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The Canadian Engineer

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The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

City Survey Monuments

A Review of the Practice of Several Canadian Cities—Permanent City Survey Monuments are Desirable—Some Details of Cost.

By H. L. SEYMOUR, A.M.Can.Soc.C.E.

TO facilitate town planning or, in other words, to make possible the intelligent development of our cities and towns, Mr. Douglas H. Nelles, D.L.S., M.Can.Soc.C.E., on "The Mapping of Canadian Cities,"* emphasized the necessity of large-scale maps prepared from adequate surveys. As to survey monuments, Mr. Nelles may be quoted as follows:—

"Too much cannot be said about the importance of leaving permanent survey marks. It very often happens that an expensive survey is made and no permanent mark left upon the ground. The only results of such survey would be its plan or map. In many cases when certain information is wanted it becomes necessary to make another survey; a large amount of resurveying is done that would not have to be done if permanent marks had been left on the original survey," and "From these published results of the traverse the distance and azimuth between any two stations in the whole district could be computed accurately. They could also be authorized by a special act of legislature to act as the basis for land surveys and be used in the description of property."

In the first extract quoted, Mr. Nelles has, of course, particularly in mind traverse surveys to which topography is referenced and which are tied in to the main triangulation system described in his paper. Such remarks apply equally well to monuments used to mark block or street corners in any city where no expensive triangulation has as yet been attempted.

In most eastern Canadian cities no real corner monuments exist except in the memories of, or in the records of private marks cherished by, some early established surveyors. In most of the western provinces legislation has now been enacted the effect of which is to render possible the resurvey of a city independently, if necessary, of private information held by any surveyor.

Experience has shown that any community is always more or less handicapped by a system of survey that has no real marks or monuments on the ground. Permanent city survey monuments are eminently desirable. They are of value to land surveyors in property location and to engineers in the location (both horizontal and vertical) of various municipal utilities.

The value of city survey monuments has been more generally recognized in the West than in the East. Some time ago the writer began to collect information from various authentic sources as to Western Canadian practice in this respect. In the different answers received the subject was well covered, and such information is now submitted as being of value to engineers and surveyors interested in municipal work.

*See *The Canadian Engineer*, January 6th and 13th, 1916.

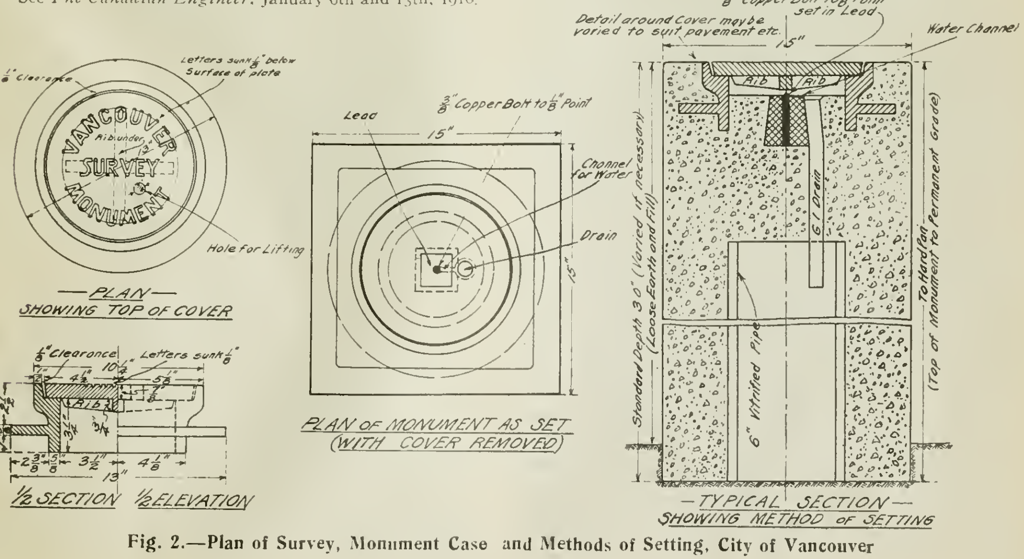


Fig. 2.—Plan of Survey, Monument Case and Methods of Setting, City of Vancouver

Saskatoon and Regina

By E. H. Phillips, D.L.S., S.L.S.,
Acting Chief Surveyor, Land Titles Office, Regina, Sask.

"I may say that the special surveys made in Saskatoon and Regina have not been registered. . . . At Saskatoon the block corners at which I found nearly all the original stakes were marked by concrete monuments about 9 ins. in diameter and 30 ins. deep in the form of a cylinder cast in a hole bored in the ground at each corner with a post-hole auger. In the top of each was set a small iron pin extending about ½ in. above the concrete. The tops were shaped in a mold made for the purpose and the iron pin placed from reference points in the exact position formerly occupied by the original stake. The monuments, it will be seen, are therefore at the true corners. . . .

"This year (1916) we are having our Special Surveys Act amended so that it will provide the machinery for dealing with the Saskatoon and Regina surveys, and it will be possible to record plans showing the retracement surveys and they will become the governing plans for locating lots, etc. . . .

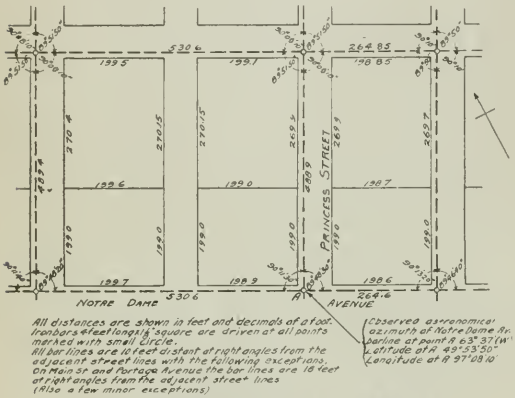


Fig. 1.—Sample Section of Winnipeg Special Survey Plan

"As regards Regina, W. R. Reilly made a survey some years ago which could not be registered. He used a system of offsetting five feet from street lines and placed one monument at each street intersection. The evidence on which this survey was made was not very abundant as practically all the stakes in the original survey of Regina are gone. When the new act is passed we expect to deal with this survey and have it recorded.

"He used concrete monuments with an iron pipe embedded in the concrete. I do not know what style of monument will be adopted as yet in future surveys and the matter was not specified in the new act as we considered that, as the operation of the act is limited to cases brought before the master of titles, by petition to the attorney-general, we would be in a position to treat each individual case as the conditions warranted, as the instructions for the survey will likely be compiled in this office.

"In the recent special survey at Saskatoon, which comprised only seven or eight blocks, I used 5-foot iron bars (solid) 1¼ ins. diameter, driven flush, and defy anybody to move them except to dig them out."

Since the receipt of the letter from which the above extracts are taken, the Special Surveys Act referred to by Mr. Phillips has been amended.

Prince Albert

By R. H. Montgomery, B.A.Sc., D.L.S., S.L.S.,
Prince Albert, Sask.

"Instructions were issued for a re-survey of this city in 1911. After spending about eight months on this work the surveyor gave it up and his work was a total loss to him and no benefit was derived from it by the city. His method was to mark reference lines on each street and avenue about 9 ft. from one street line and established by monuments about 1,000 ft. apart. The block corners would be established from intersection of these reference lines. The monuments were a cement block truncated cone such as would be formed by a five-gallon pail with an iron spike standing about 1 in. out of the smaller end. This was set in the ground about 9 ins. below the surface. A cast-iron hollow casting set on this block had a removable cap.

"This monument, in my opinion, is not satisfactory, chiefly by reason of the fact that the blocks were prepared beforehand and after being set in place did not remain in position.

"In 1913 the master of titles was compelling this city to carry out a re-survey under the Special Survey Act of

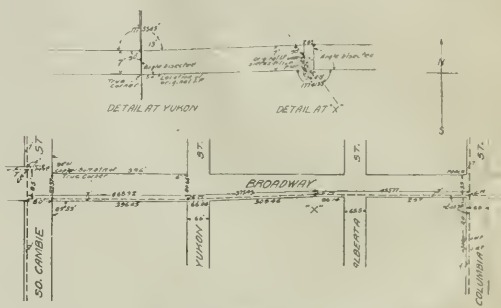


Fig. 3.—Location of Monuments on Broadway Street, Vancouver

the province, but owing to financial conditions arising the city was unable to do it, and the matter was left in abeyance up to the present.

"In this proposed survey the block corners were to be referenced by monuments about 3 ft. out and the monuments were to be simpler and more permanent. Briefly, a hole was to be bored out by a post auger 8 ins. diameter by 3 ft. deep. This was to be filled full of cement and an iron pipe 1 in. diameter was to be sunk in it. By this means a picket could be readily held upright in the pipe or the transit could be set directly over it."

Winnipeg

By R. H. Avent, M.L.S.,
Secretary of the Association of Manitoba Land Surveyors,
Winnipeg, Man.

"I am forwarding, as requested, a sample section of the Winnipeg special survey plans (see Fig. 1). These plans, nine of which were made about the year 1890, and ten made in the years 1907 to 1912, were drawn to the scale of 100 ft. to 1 in. and average about 4 ft. x 7 ft.

"The monuments used are square iron bars 1⅛ ins. x 4 ft., pointed and driven level with the pavement or ground surface, as the case may be. Before adopting this style of monument, the city surveyor made extensive inquiries

and studied the experience of other American cities, and is of the opinion that they are probably the most suitable in a city which is constantly developing.

"It has been found that the excavation of a sewer along the centre line of a 66-ft. unpaved street will cause the ground at the 10-ft. offset line to shift as much as 1/10 ft. Again, without a previously planned system of street levels it would be useless to use expensive survey monuments. It is therefore concluded that these iron bars, which can readily be adjusted if disturbed from their position, are the most satisfactory for local conditions."

The latitude and longitude of all stations of the special surveys carried out by G. B. McColl, D.T.S., from 1907 to 1912 were deduced from observations taken in the city of Winnipeg by Dr. O. J. Klotz, Dominion Astronomer.

Vancouver

By W. H. Powell, D.L.S., B.C.L.S.,
City Surveyor, Vancouver, B.C.

"I came to Vancouver as city surveyor in 1912, and so am hardly qualified to speak of early surveys, their

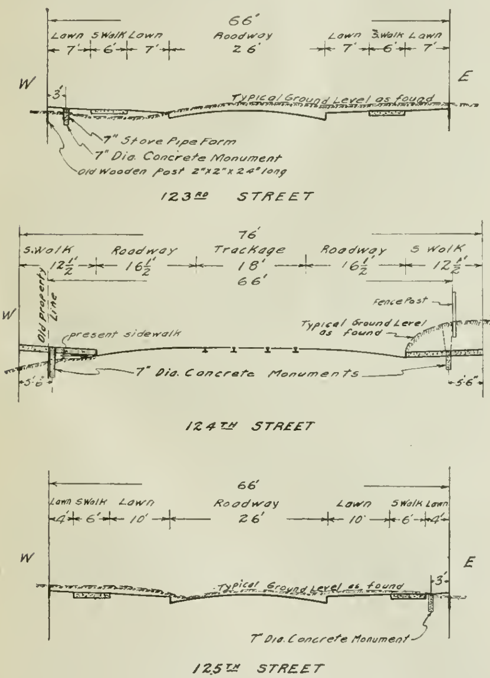


Fig. 4.—Proposed Street Sections at Edmonton

accuracy, and method of marking and referencing corners; but this I will say, that not a monument or reference point other than marks on sidewalks, iron posts or wooden hubs existed. The latter are very primitive, and ought to have no place in 'wild cat' subdivisions, much less in city surveys. Iron posts are unsatisfactory, for they may easily be bent or displaced, torn out by city workmen or others, and often 'replaced in the same spot,' which is really the most disastrous occurrence. Marks and cuts on concrete sidewalks have some merit for reference of building points; but this winter's (1916) frost, which has thrown the sidewalks considerably, has shown us that for survey purposes, these points are not dependable.

"Accordingly, one of my first acts on coming to the city was to design a monument to suit conditions here. I enclose a blue print showing in some detail what we have decided on. (See Fig. 2.) We have found it very satisfactory. I am also enclosing prints (see Fig. 3) to show how located as a reference point, and its relation to the street intersections. I also show on the plans another method of referencing corners, by means of a copper bolt in the base stone of a permanent building.

"The question of location of monument resolves itself into three possibilities: The point of intersection of centre lines of streets; the point of intersection of property lines; or an offset of, say, 7 ft. from the property line.

"In the first, the setting of the monument on the centre line is bad, because it makes a discontinuity in the pavement, and increases the cost of construction and maintenance. Except where the pavement is laid on very solid subgrade, there is a very perceptible jar to the transit instrument as traffic passes to and fro. On a street occupied by car lines, the distance between tracks is not sufficient to set a transit and have cars on either side, and thus only the short interval between cars is left for manipulation. The one advantage that is apparent is the simplicity of mathematical calculation when streets intersect at other than right angles.

"The second position is out of the question on business streets where buildings are constructed right to the property lines; and in residential streets, fences, hedges, etc., will prevent measurement along the line of the monuments, the surveyor having to resort to offsets. This increases the cost of surveys, and the chances of error. But by placing the monument on an offset of 7 ft. (which in Vancouver brings it 1 ft. inside of inner line of sidewalk) from the intersection of property lines, and adding extra monuments where we have jogs or deflections, we may have the advantages of the first two suggested positions.

"But in some cases, original posts were placed on the centre line of streets, and I hold that the location of these original points should be perpetuated by monuments placed to take the exact original position, but in most other cases a convenient offset is desirable.

"Our bench marks are independent of our survey monuments. I suggested placing in the monument a copper bolt 1¼ ins. in diameter, with spherical head, for bench mark, but the suggestion has not been adopted, and levels are not under my control. An objection lies to this method, as a careless rodman might drop his rod on the survey point and batter it.

"The cost of the copper bolt in the permanent building amounts to about $.75 to $1 each, depending on the skill of the stonecutter who drills the hole, as a very large percentage of the cost is labor.

"The cost of the concrete monument, based on manufacture of eight this week (March, 1916), is as follows:—

"Labor, two men 7 hours, $4.25; gravel, 1 yard, $1.10; eight cast iron tops, 34½ lbs., at $3, $8.28; eight sacks cement at $.60, $4.80; eight pieces vitrified pipe at $.25 per foot, $4; total, $22.43; say $2.80 each. Our contract price for castings this year (1916) is higher than that quoted, and at present, cost might be $.50 each higher.

"Cost of setting the monument depends upon distance of transportation, nature of the soil, skill of the men, etc. By taking an average of about one hundred and fifty, which I have set, the setting price works to about $2 per monument, including lead, copper and labor.

"My method of setting is to locate the point by survey, say, to the nearest half inch, which is close enough for the setting of the monument block. This setting may be done by a reliable workman without any surveyor's assistance, if grade is given beforehand. The monument is then left for two weeks or so to see if there is any settlement; so far I have not been troubled by that. Then the point is referenced exactly, transit plumbed over the point, top removed, copper point set in clay to support it placed precisely under plumbob, and hot lead poured in and left to cool. In this, one workman is used to assist in getting wood, carrying crucible, etc.

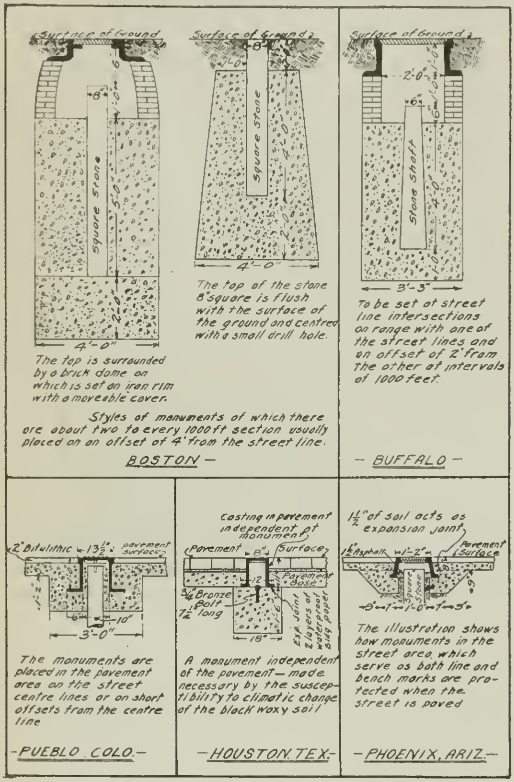


Fig. 5.—Sections of City Survey Monuments

"The survey work is not reckoned at all in the cost of the monument, as that is covered in a distinct appropriation.

"Several of the surveyors in the city when on private work of any magnitude reference their points and ask us to place the monuments. This is a great help to us, as at present the engineering and surveying staff in the city hall has been cut to a minimum.

"In order to prevent any creep due to the creep of the sidewalk, we leave a ¾-in. space between monument and sidewalk, which is filled with pitch and sand, similarly to the regular expansion joint in the walks.

"Our British Columbia Special Survey Act is occasionally called upon to correct errors of some magnitude. But the government has not yet granted or ordered a complete survey of the city. This will come shortly, we hope, and I am strongly of the opinion that this survey can be made without seriously disarranging occupation, if judgment and not bullheadedness is used."

Edmonton

The writer was commissioned early in 1914 to make the necessary surveys and plans under section 485 of the Edmonton charter for the widening and opening of certain streets in the city of Edmonton. The commissioner of public works decided that it would be advisable to plant reference monuments to perpetuate the survey. It was also decided that the cost of each monument must be small. For this reason the type of reference monument adopted was a 7-in. cylinder of concrete poured on the ground. This cylinder ordinarily was about 3 ft. long. As the top of each monument was brought to what will be the finished grade of the street some rather deep excavation was required. In other cases the monuments had to be erected several inches (in one case about 24 inches) above the ground level. At the suggestion of the writer the forms used were 7-in. stove pipe, two or more lengths being employed if necessary. These probably provide the cheapest forms and they do not have to be removed. It is felt that monuments of such a nature, if they project any distance above the ground, are liable to displacement before the street grade is actually completed. However, the question of cost prevented a more permanent form of monument being considered. As a cost-saving feature it was decided to make the actual reference mark in the flat top of the concrete monument a brass tack driven flush in a small inverted cone of lead, the lead to be poured hot into a cavity left by the removal of a wooden plug placed in the concrete before it set. It was subsequently found that in the method adopted in pouring the concrete the actual reference point might be as much as an inch off centre of the concrete cylinder, bringing the point, therefore, off or at the edge of the lead. On this account the last monuments made were given a plain concrete top. A small concrete drill was then used to make a hole at the exact point in the hardened concrete of about an inch in depth. This hole was plugged with lead and a brass tack driven therein.

Fig. 4 shows the cross-section of several streets on which the block corners were marked by reference monuments. Originally 124th Street was only 66 ft. wide; the survey provided for its widening to 76 ft. By placing the reference monuments 5.5 ft. from the new property lines they came just 0.5 ft. from the old fenced property lines. Old posts, where found, were not displaced and the reference monuments did not interfere with the sidewalk at present constructed about a foot from the fence.

In all cases the method adopted was to reference the block corners by monuments erected in the street at right angles to the blocks to which they referred. To locate any block corner it is therefore not necessary to pick up the alignment of the cross-street as is required with some other methods.

When the corners of the blocks to be referenced had been found or re-established by the writer and his staff, engineers from the city staff located, where necessary, a reference hub marked with a tack one foot from the point where the centre of the monument was to be erected. They also determined the distance above or below which the top of the monument was to be set that it might be level with the finished grade of the street. By laborers the monuments were then constructed. Finally, the exact

reference point on the monument was determined by the writer and staff.

The cost of material and labor for monuments erected under such conditions averaged, in 1914, according to figures supplied by Mr. A. W. Haddow, acting city engineer, about $4 per monument.

From various authentic sources information has been collected by the writer relative to monuments, or interesting features relating thereto, erected or proposed in the cities designated in Fig. 5.

Under ordinary conditions and within reasonable limits, the mass or weight, the area of cross-section, and the depth of base below ground surface are functions of the degree of reliability that may be placed on any monument as to its remaining in accurate alignment. In our changeable Canadian climate, experience has shown that to preserve its alignment a monument should have its base well below the frost line. It is here suggested that in some cases it might also prove advisable—though possibly seldom practicable—to provide for drainage of the entire monument. And especially if the monument is to act as a bench mark should every such precaution be taken. In cities such as Edmonton, visited by severe cold in the winter, the writer understands it is the practice to check up bench marks in the spring and it is usual to find that some concrete bench marks—even those extending 8 ft. or more below the ground surface—have varied in elevation since the preceding fall.

Having regard to local climatic and other conditions, it is submitted that Mr. Powell has designed for the city of Vancouver a survey monument that is not excelled on this continent.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS (TORONTO SECTION)

A most attractive programme for 1918 has been arranged by Mr. A. H. Hull, chairman of the Papers Committee of the Toronto Section, A.I.E.E. It has been found desirable to hold two meetings in every month (first and third Fridays), and the arrangements for 1918 are:—

January 18th—"Commercial Applications of Synchronous Motors."—Morris J. McHenry, Canadian General Electric Company, Toronto.

February 1st—"The Laws of Dielectrics."—Charles E. Skinner, Research Division, Westinghouse Electric Company, Pittsburg.

February 15th—"Technical Education in an Engineering Works."—Channing R. Dooley, Educational Department, Westinghouse Electric Company, Pittsburg.

March 1st—"Recent Developments in Transformer Practice."—John J. Frank, G. E. Company, Transformer Engineering Department, Pittsfield, Mass.

March 15th—"High Voltage Testing (with experiments)."—William P. Dobson, Hydro-Electric Power Commission Laboratories.

April 5th—"High Tension Insulators from the Operating Viewpoint."—Paul Ackerman, Toronto Power Company.

April 19th—Annual meeting, dinner and election of officers.

SANITARY STREET CLEANING

By Geo. A. Wiseman, M.E.
Chief Engineer, The Tiffin Wagon Co.

SINCE the early days when street paving came into vogue, one of the most serious problems confronting the authorities in the different municipalities has been to devise an efficient and satisfactory method of keeping the pavements clean.

Before the knowledge of bacteria and the ease by which they are spread, very little attention was given to the sanitary feature of street cleaning. In many municipalities streets were allowed to become littered with all sorts of refuse, including garbage and ashes, cattle and horse droppings, and all other kinds of filth.

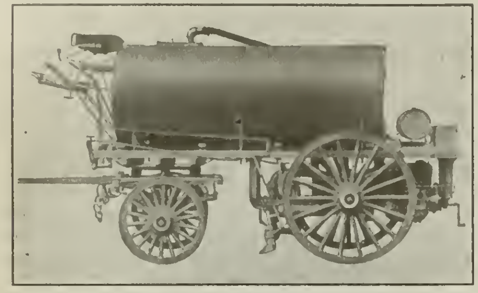
Since it has been proven that disease bacteria exist and thrive in the accumulated filth of city streets, the efforts of many health experts, civic authorities and others, who have the welfare of the people at heart, have been directed toward the development of methods that will keep the filth from the streets in an entirely sanitary manner, preventing, so far as possible, even the slightest accumulation.

In many of our more progressive cities, the health authorities are conducting researches along the line of sanitation in the matter of street cleaning. Recently the city analyst of St. Louis, Mo., conducted an examination of the filth accumulation in the gutters in the down-town section of the city. In one cubic inch of this filth, there were found to be more than sixty million bacteria of the most virulent type, including tuberculosis, yellow fever, typhoid, small pox, scarlet fever and many others. Possibly this is not by any means an extreme case, and like tests or examinations in all our large cities would be found practically parallel. That this condition of affairs is extremely serious, not even the most indifferent citizen can deny, and to alleviate it is the duty of every citizen, and especially of municipal officers to whom the health of the people is entrusted.

Horse-Drawn, "Automatic" Flusher

Previous to the scientific discovery of germ life, about the only difficulty that seemed to confront the municipal authorities was allaying the dust on the streets, so that the citizens might not suffer inconvenience from it. This brought about the invention of the sprinkling cart which has been in use for many years. The method of scraping, sweeping and hauling away street accumulations by what we call the "white-wing" system, has also been employed in the large municipalities for a long time.

Later, power sweepers were invented. The filth accumulations were then swept into the gutter and either allowed to lie or were scraped into piles and hauled away to some ravine or low spot and there dumped. This antiquated method is still being used in many municipalities where a criminal neglect of proper sanitation is allowed to exist.



Horse-Drawn, Power-Pressure Flusher

It should be apparent to even the casual observer that sweeping by a mechanically driven broom has no effect except to clean off the highest surfaces and to fill up all crevices and low spots, only the surplus being swept to the gutter. The first gust of wind that strikes the surface of the street, picks up the disease-laden filth in the form of dust, and spreads it broadcast, thereby seriously endangering the health of the community.

A few far-seeing men have realized the unsanitary condition brought about by this antiquated method and other similar ones, and have spent their time and money freely toward the development of more sanitary methods of cleaning streets, and the inventions of pick-up machines, squeegees and flushers are the results.

From the standpoint of sanitation, no device compares favorably with the street flusher. The more modern machines are very efficient. It is possible to keep a vast area of paved streets absolutely free from dust and the consequent accumulation of filth, by the use of a single machine. No other method approaches the flushing machine in this regard.

It is not the purpose of this article to discuss other methods of street cleaning except casually, but to outline a brief history of the development of the flusher apparatus from pioneer days to the present time, as it is conceded by practically all authorities that flushers are the most efficient and sanitary devices.

Many devices (including the Howland, McDade, Rich, Murphy and others) were exploited in the early days of flushers, all of them touching more or less upon the principle of street cleaning by portable water carts, nozzles, valves, etc., but it remained for Leopold Frank Ottofy to perfect an efficient device that delivers a stream of water at a forward angle and laterally to the street pavement, under pressure. He applied for patents November 10th, 1902, and they were allowed on July 18th, 1905.

The method of carrying water by cart, wagon or other vehicle was declared not patentable, however, the final award being made entirely on the forward and lateral discharge of the flushing stream by an elongated or slotted nozzle of thin, flat shape. The system evolved by Mr. Ottofy met with opposition, many arguments, logical and otherwise being advanced deprecating the efficacy of his device.

The principal early objections to the flushing device were that a stream of water under pressure would destroy pavements, and that it would wash the filth accumulation into the gutters and catch basins in such volume that the basins and sewers would become clogged and cause endless trouble. These have been proven to be fallacies. A rain storm of moderate volume will carry vastly more sand or soil and other debris into the catch basins and sewers than will the most strenuous street flushing operation. Moreover, where street flushing is properly done, there is never any great accumulation of filth. Consequently an amount of refuse or other matter enters catch basins which can easily be taken care of by the natural flow of water in the sewers.

The earlier type of flushing machines, of a type commonly known as the "automatic," met with disfavor owing to the impossibility of maintaining a constant pressure until the tank or receptacle was emptied. This apparatus consisted of a water tank and an auxiliary or air storage tank into which the air contained in the main tank was forced by the water flowing from the hydrant, this confined pressure being used, by means of a system of valves, to furnish the necessary pressure for flushing as the water became exhausted from the main tank.

This type of machine required careful observation by the operator that a small quantity of water be retained in the main tank to prevent the stored air exhausting through the discharge nozzles. Moreover, it was also practically inoperative in localities where hydrant pressure was below fifty pounds.

In May, 1904, Maj. John Woodbury, Commissioner of Street Cleaning, New York City, instituted a series of comparative tests between the hose method of street cleaning, the Murphy cart and the Ottofy cart. The test was conducted on Madison Avenue. One block was cleaned by each method, and the following were the results:—

Hose and three men used 156 cubic feet (1,218 U.S. gallons) of water. Time required, 12¾ minutes.

Murphy cart used 96 cubic feet (750 U.S. gallons) of water. Time required, 22½ minutes.

Demonstrating Motor-Driven Flusher on West End Avenue, New York City

Ottofy cart used 45 cubic feet (352 U.S. gallons) of water. Time required, 10 minutes.

This test clearly demonstrated the efficiency and economy of the Ottofy style of nozzles and resulted in the discard of the other methods then in vogue.

The defect, as regards pressure, in the automatic type of machine was realized, and subsequent to the issuance

of the Ottofy patents there were issued what is known as the Johnson patent, covering a power plant used to operate a centrifugal pump applied to a water supply tank in such a manner that the water is taken by gravity and suction from a receptacle which merely carries a given quantity of water under no pressure whatsoever excepting its own weight. The pressure, or force of discharge, is generated entirely by the centrifugal pump and power plant.

Motor-Driven Flusher Cleaning Entire Street from Curb to Curb

Practically all the other features of the Ottofy patent were applied to this construction, and there was obtained a uniform discharge of water under pressure until the entire contents of the supply tank or receptacle were exhausted. This latter type of machine is now being used in many of our smaller cities, and until the advent of the motor flusher, it was considered to be the most modern style of equipment.

During the past three pears, however, the underlying principles of the power plant and the Ottofy patent nozzles have been applied to motor-driven apparatus with splendid results. In the first attempt to utilize a motor truck of large capacity, what the writer considers to be a very serious error was made in attempting to supply the necessary power to the pressure pump from the vehicle or propelling motor.

While this was a decided improvement over the horse-drawn vehicle, principally through the added volume of water carried and the added speed obtained from the motor apparatus, the writer and other engineers have pointed out the inability of one man to operate the machine successfully, the wear and tear and fuel cost caused by operating the ponderous vehicle motor at a speed sufficiently great to obtain the necessary pressure for satisfactory flushing, the necessity of operating the vehicle in low gear so that the vehicle speed may be kept down to a point where satisfactory cleaning of the pavements may be accomplished, and the variation in pressure owing to the speed being retarded while the machine is climbing a grade and accelerated while going down grade (unless extreme care is exercised).

It requires uniform pressure to obtain the best results in cleaning streets. Some of the earlier machines of this type provided a by-pass valve which permitted a portion of the water to return to the supply tank when the pump developed more than the necessary pressure. This proved to be expensive because excessive speed was maintained at all times, using an excessive amount of fuel, and a loss was involved in pumping water back into the receptacle.

The difficulties involved in all of the above described machines are almost entirely eliminated by the latest "two-motor system." This new system uses a standard motor truck chassis, equipped with a propelling motor and other mechanism that is no greater or smaller in capacity than is normally required in a regular commercial truck of like size. On the motor truck chassis is mounted a supply tank that carries any given quantity of water under absolutely no pressure, and a separate gas motor and centrifugal pump, both of the proper capacities to deliver the flushing streams on the pavement at a pressure ample for the dirtiest streets.

The vehicle itself is controlled in a normal manner by the operator, the flushing unit of power plant being operated altogether independently. A variation in speed of the vehicle owing to bad pavements, street car crossings or other traffic conditions, does not affect the control or pressure of the flushing unit in the slightest degree. The operator can slow down the vehicle at will and even stop it entirely, yet maintain an absolutely constant flushing pressure. Or he can increase or decrease the flushing pressure at will. This system is economical for the reason that the vehicle can be operated on high gear at all times where traffic conditions or grades permit.

The pump motor, being only of sufficient capacity to handle the pump, is economical. When the flushing operation ceases, the power is shut off and the motor and pump become dead, so far as the cost of operation is involved. Consequently, the large vehicle motor can be safely relied upon to stand up to its normal life. The fact that the pump motor is operated but intermittently also lengthens its life.

The extreme efficiency of modern electric ignition and gas carburetion is too well known to cause any anxiety in the minds of well-posted motor men.

The results obtained by the "two-motor system," when properly manipulated, shows that upwards of five square yards per gallon of water can be perfectly cleaned. At all depressions in the pavements, at intersections and where there are unpaved cross streets from which dirt is carried onto the pavements, the variable speed feature of the "two-motor system" machines demonstrates their superiority.

Flushing Streets in Ottawa, Ont.

Commissioner of Works A. F. Macallum, of Ottawa, in his report to the Board of Control for the year 1917, states that by the use of motor-driven and horse-drawn flushers he saved $8,650, compared with the expense in 1916 of operating horse-drawn sprinklers. The flushers also made possible a further saving of $12,400 in street sweeping expense.

It is now generally recognized that flushing is really the only sanitary system of cleaning streets. There are only a few sections in the very largest and most densely populated cities where they can not be used to the very best advantage. Heavy traffic at all hours of the day and night is the only thing that can interfere with its successful operation. These conditions are being met by having

the business sections of large cities flushed during the night, selecting hours when the traffic is the lightest. No other method of street cleaning compares in cost with the very inexpensive flushing method, and certainly no other method approaches flushing from the standpoint of ideal sanitation.

CRACKS IN CONCRETE PAVEMENTS

SPECIALISTS of the Office of Public Roads of the U.S. Department of Agriculture have recently concluded a seven-year study of cracking in concrete pavements, which has included measuring the amount of expansion and contraction caused by alternate wetting and drying and by temperature changes in concretes of various proportions of ingredients. The results are given in a report just issued by the department.

The report makes no attempt to apply the results to the practical side of road construction, although certain general conclusions drawn, it is said, may be capable of utilization by engineers. These conclusions are:

1. Neat cement, when allowed to dry, first contracts rapidly, then more slowly. The amount of contraction seems to vary with the cement, size of specimen, and condition of atmosphere in which drying takes place. The amount at 28 days is about 0.1 per cent. and at 6 months about 0.2 per cent.

2. Mortar contracts on hardening in air and expands on hardening in water. The contraction in warm, dry air at 28 days is about 0.045 per cent. for 1 : 2 and 1 : 3 mortar and at 6 months is 0.078 for 1 : 3 mortar and 0.085 for 1 : 2 mortar. The expansion in water is 0.01 per cent. for 1 : 3 and 0.017 for 1 : 2 mortar at 28 days, and at 6 months 0.013 for 1 : 3 and 0.02 per cent for 1 : 2 mortar.

3. Both 1 : 2 : 4 and 1 : 3 : 6 concrete contract on drying in warm, dry air from 0.02 to 0.04 per cent. at 28 days and from 0.04 to 0.07 per cent. at 6 months. When hardening in water an expansion of about 0.01 per cent. takes place at 28 days and 6 months in 1 : 2 : 4 and 1 : 3 : 6 concrete.

4. The richness of the mix of concrete seems to exert a small influence on the contraction; the richer the mix the greater the change in length.

5. Concrete alternately wetted and dried may be made to expand and contract owing to these causes. The expansion due to wetting is more rapid than the contraction on drying. The thoroughly dried specimens of concrete do not recover their original wet length when immersed.

6. Concrete stored in the outer air and exposed to the weather does not contract to the same extent as the above described specimens except under very dry conditions.

7. A waterproof covering, such as coal tar, prevents the rapid change in moisture content and greatly retards the expansion and contraction.

8. Reinforcement decreases, but does not prevent the shrinkage and expansion of concrete due to drying and has no effect on temperature changes. Reinforcement can not, therefore, entirely prevent cracks, but seems to distribute them and keep them small.

9. Concrete roads are affected by both temperature and moisture. When the drainage is good and the subbase not wet the temperature effects seem to be most important. A wet sub-base may add to the temperature expansion by about 0.01 to 0.02 per cent. The restraining effect of friction at the base seems to be almost negligible when figuring temperature and moisture expansion and contraction. In very dry climates shrinkage due to drying must be added to contraction due to fall in temperature. A shrinkage of 0.04 per cent. (one-quarter inch in 50 feet) is a safe allowance due to drying.

10. Temperature at time of construction of road should be considered in designing joints. Cold-weather construction requires a full allowance for temperature expansion and, on wet sub-bases, for moisture expansion also. Hot-weather construction theoretically requires no joints at all, even in wet sub-bases, as the temperature contraction exceeds the moisture expansion. However, the difficulty of keeping the cracks clear probably renders joints imperative.

NOMINATIONS FOR OFFICE IN CAN. SOC. C.E.

The following gentlemen have been nominated for election as officers and members of council of the Canadian Society of Civil Engineers at the annual meeting to be held next month:—

President, H. H. Vaughan, Montreal; vice-presidents, H. E. T. Haultain, Toronto; R. F. Hayward, Vancouver; J. G. G. Kerry, Toronto, and C. H. McLeod,* Montreal.

Councillors, District No. 1—C. H. Bristol, Ernest Brown, J. M. Robertson, O. Lefebvre, all of Montreal; District No. 2—W. A. Duff, Moncton, and D. H. McDougall, Sydney; District No. 3—N. E. Brooks, Sherbrooke, and Hon. G. R. Smith, Thetford Mines; District No. 4—John Murphy and Alex. Gray, Ottawa; District No. 5—L. M. Arkley and Peter Gillespie, Toronto; District No. 6—G. D. Mackie, Moose Jaw, and L. A. Thornton, Regina; District No. 7—A. E. Foreman, Victoria, and E. G. Matheson, Vancouver.

*Since deceased.

ENGINEERS RECEIVE HONORS

The following men have been awarded the D.S.O. order in the New Year's honors list:—

Major Alexander Anderson, engineering division.

Lieut.-Col. Thos. Anderson, B.Sc. and associate member of the Canadian Society of Civil Engineers.

Lieut.-Col. Fred. Clarke, associate member of the Canadian Society of Civil Engineers. Lieut. Clarke is a graduate of the School of Practical Science, Toronto. Before enlisting he was employed in the Canadian Northern Ontario Railway Right-of-Way Department at Toronto.

Lieut.-Col. James Cornwall (Railway Battalion).
Lieut.-Col. Atholl Griffin (Railways).
Major Dan Hatzberg (Engineers).
Lieut.-Col. C. Hervey (Railways).
Brig. Wm. Lindsay (Engineers).
Major Edison Lynn (Engineers).
Lieut.-Col. Wm. MacKendrick (Engineers).
Lieut.-Col. Lawrence Martin (Railways).
Major Eric Pepler, Toronto (Engineers).
Lieut.-Col. Kenneth Ramsay (Railways).

Lieut.-Col. Blain Ripley, of 6 Nanton Court, Nanton Avenue, Toronto. Lieut. Ripley is a member of the Canadian Society of Civil Engineers.

Major Robert Rogers (Engineers).

Major Harold Trotter, graduate of the Royal Military College (Engineers).

SOME CANADIAN PUMPING PLANTS

By A. Huguenin
Chief Hydraulic Engineer, Escher Wyss and Co., Zurich.

IN places where the water needed for the water supply of town and communities has to be taken from lakes, rivers or wells, on account of the geological nature of the country, greater power is required than in the case of places favorably situated in narrow valleys, in order to produce the necessary pressure for the delivery of the water where required.

When working out the plans of such plants, it is necessary for economic reasons to adopt as low a head as possible, and to erect the water towers or reservoirs only as high as is absolutely necessary in order to raise the water without difficulty to the top floors of the houses.

Special additional pumps have to be installed in the cellars of exceptionally high buildings in order to increase the water pressure. In general, the same principle must be adopted for protection against fire, or special fire engines have to be brought to the spot to produce the additional pressure required for reaching the top of the houses with the water jets.

Such installations are to a certain extent disadvantageous, particularly in cases where the straggling nature of the place involves the loss of considerable time until the fire can be efficiently brought under control. The erection of plants which can be gotten into working order in a minimum of time, therefore, considerably minimizes the danger of the fire spreading, and facilitates its rapid extinction. This is best accomplished by installing in the streets water hydrants to which the necessary hose can be quickly connected. For such installations, however, the pressures in the pipelines must be sufficient for producing the required height of jet. One and a half to double the normal pipeline pressure must usually be provided in order to obtain the necessary height of jet.

For these purposes special fire engines can, of course, be employed, connected up to the main network of pipelines or to a special system of pipelines. Engines of this description are expensive, however, and efforts have been made to solve the question in a way which avoids this disadvantage and admits, if possible, of the utilization for fire service of waterworks pumps which are used for normal service.

The simplest way to fulfil the conditions imposed would be the use of plunger pumps, as it would then only be necessary for the output of the driving engine to be sufficiently large to sustain the load produced by the highest pressures. However, the use of plunger pumps involves considerable danger in working, because there is the constant risk of pipe fractures owing to careless attendance or to the failure of the safety devices which are absolutely necessary with such pumps.

Owing to its great adaptability and to its being entirely free from those disadvantages, the centrifugal pump almost exclusively holds the field in this respect, and many such pumping plants have lately been put up.

The twofold service of the centrifugal pump for water supply and for fire purposes can be attained in different ways; the simplest is to increase the speed of the motor or engine beyond that used in normal working, and thus produce greater pressure. This proceeding can only, however, be adopted in cases where the driving engines admit of the speed being increased in the simplest possible manner, *i.e.*, chiefly with steam plants and electric plants using direct current. In most cases, however, we have to refrain from regulation of the speed, as the current generally used for waterworks is three-phase. With this current there are great difficulties in the way of speed regulation, as it is essential that the highest economic utilization of the motor be obtained in the normal service, *i.e.*, with the low speed. Therefore, the simple manner of regulation (by connecting resistances in the rotor circuit) is out of the question here, because the efficiency of the motor falls off considerably with decreasing speed. For this reason, only motors with change of pole connections can be employed in such cases. It is, however, generally difficult to adapt these motors to the required conditions of service. Thus practically the only expedient left with the three-phase current drives is to erect separate machine sets working normally in parallel, or to keep one set as a spare for the other so that the two sets may be connected in series by suitable pipe connections in case of fire, thereby increasing the pressure in the pipeline to double its former amount.

The several plants described below form practical illustrations of one or the other of the above-mentioned solutions, or combinations of both. The writer has chosen for this purpose four plants supplied by the firm of Escher Wyss & Co., of Zurich, Switzerland, which show the various methods in a characteristic manner. The installations are those of Deseronto, Regina, Kitchener and Port Arthur.

Deseronto, Ont.

Fig. No. 1 shows the plant of the town of Deseronto, Ont. The installation consists of one single pump running at various speeds, according to the working conditions. In this case it was particularly easy to arrange for the change of speed, as three-phase current of different frequencies was available from two different systems for the driving of the pump. The pump was therefore coupled with two motors of different types, which were placed to the right and to the left of same. The motor with six

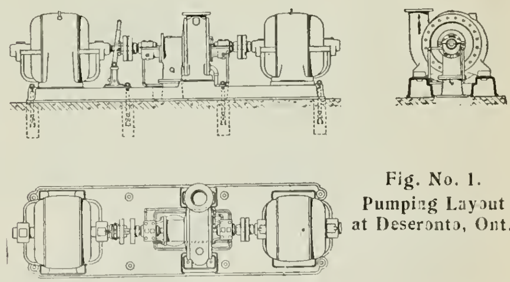


Fig. No. 1. Pumping Layout at Deseronto, Ont.

poles shown in the drawing on the right is used for normal service, whereas the motor with four poles (shown on the left) is only used in case of fire. The latter motor is, therefore, only connected with the pump shaft by means of a disengaging coupling, whilst the former motor is provided with a flexible coupling.

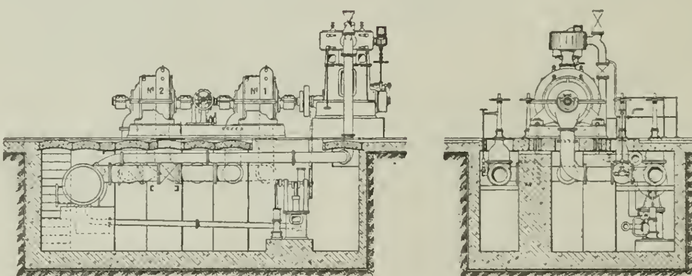
In case of fire, the right-hand motor is disconnected, the set stopped and afterwards coupled with the left-hand motor only and restarted. In normal service the pump works with the six-pole motor on the 60 cycles system at a speed of 1,160 revolutions per minute, and under these conditions delivers 60,000 Imperial gallons per hour at a manometric head of 100 ft. In case of fire, the pump is connected with the four-pole motor on the 50 cycles

system, and then runs at a speed of 1,430 revolutions per minute. The pressure thereby produced by the pump is increased to 290 ft., whereas the actual quantity of water pumped remains the same. Naturally, a considerably greater power is required, so that, although in normal service a motor output of 90 h.p. suffices, it must be possible in the event of fire, to raise the output to 150 h.p. For economic reasons, it would therefore not be advisable for the same motor to be employed in both cases, and therefore two separate motors have been installed as described above.

Regina, Sask.

For the waterworks plant of the town of Regina a combined solution has been applied, as it was necessary there to increase not only the head, but also the quantity of water. In this case, therefore, two pumps were installed, to work either in parallel or in series, capable, by the raising of the speed, of increasing the quantity of water by 25 per cent. A high-speed Belliss & Morcom steam engine, with a maximum output of 250 h.p., was chosen for this plant, as the engines of this make admit of the speed being raised for the purpose of increasing the quantity of water, in a simple manner and without prejudicing the economic working of the plant in normal service. The pumping set is shown in Fig. No. 2. The external view is more clearly shown in the photograph, Fig. No. 3.

Two pumps of exactly similar construction are combined on a common bedplate and connected with each other by means of a friction clutch coupling which can be engaged and disengaged whilst running. The pumps are driven from the steam engine by means of a flexible coupling. The pumps are connected with each other in such a way, by a system of piping, that either pump No. 1 only (installed next to the steam engine) is connected to



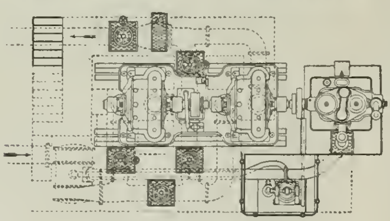


Fig. No. 2.
City of Regina
Pumping Installation

the system, or else both pumps are connected to the latter (when the greatest quantity of water is required), thus doubling the volume of water supplied.

In case of fire, the connection is changed by the closing and opening of valves in such a way that the pumps Nos. 1 and 2 work in series, whereby the pressure in the pipelines is doubled. The output of the driving engine is the same when the pumps are working in parallel or in series, and is only reduced to half when pump No. 1 is working alone. The change from one way of working to the other is effected very quickly, as it does not involve the stopping of the engine, but merely the closing or opening of four sluice valves provided for this purpose and operated from the engine house floor.

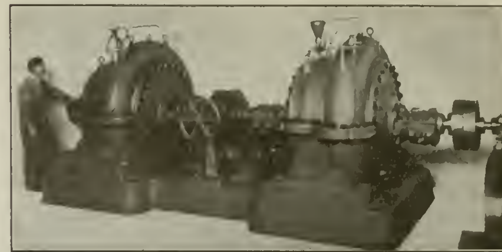


Fig. No. 3.—Pump Installed at Regina, Sask., Pumping Plant

In order to run the plant more economically, a surface condenser is provided, which is placed in the delivery piping of the pumps. Thus the water delivered by the pumps is utilized for condensing the steam. The water is only slightly heated thereby, as the quantity of water is many times larger than the quantity of cooling water required under normal working conditions for the output of the steam engine. The losses in the cooling pipes of the condenser are also extremely small, because, owing to the large quantity, very short water passages can be selected, and one single flow through the condenser proves to be sufficient.

In normal working, the set runs at a speed of 375 revolutions per minute, and delivers 209,000 Imp. gallons per hour at a head of 138 feet. In case of fire, the head is increased by changing to 276 feet, and the quantity of water is reduced to 104,500 Imperial gallons. Should this quantity not be sufficient, the speed of the engine is increased to 400 revolutions per minute, whereby the quantity of water is raised to 130,000 Imperial gallons. This regu-

lation of speed admits of an economic utilization of the plant also in normal working. As, in the ordinary course, only 104,500 Imperial gallons are required, the second pump would have to be connected up to increase the quantity of water to double, but this does not, of course, represent the real increase required. The latter is actually

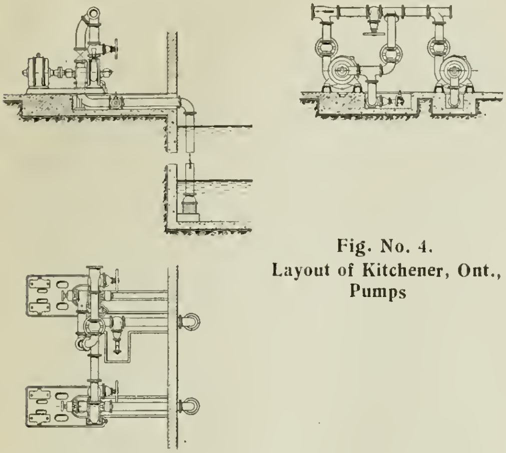


Fig. No. 4. Layout of Kitchener, Ont., Pumps

only a gradual one, and consequently the plant will be working more economically when the quantity of water is first increased to 130,000 and then to 209,000 Imperial gallons per hour.

Kitchener, Ont.

For the water supply of Kitchener, Ont., the pumps had to be connected up to the available three-phase current system of 50 cycles. In consequence, two pumps, working at constant speed, were installed. In order to have a sufficient reserve for normal working, the two sets have been entirely separated, and each provided with its own driving motor. Each set delivers 48,000 Imperial gallons per hour at a manometric head of 200 feet and at a speed of 1,450 revolutions per minute, and is coupled to a driving motor of 80 h.p.

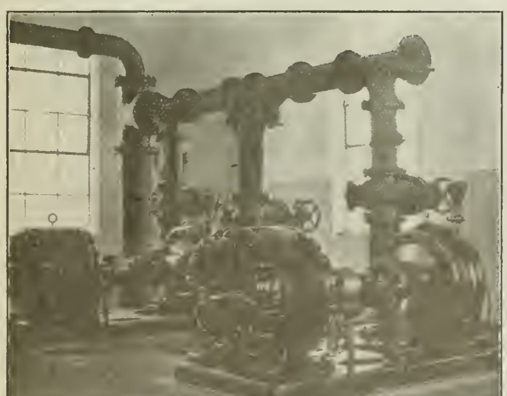


Fig. No. 5.—Interior View of Pumping Plant at Kitchener, Ont.

In order to obtain an increased pressure in case of fire, the two pumps are connected by means of a system of piping, thus enabling them to work in series. The head then increases to 400 feet, whilst the quantity of water remains the same. For the sake of economy, this piping is not installed in the cellar, but right above the pumps. Fig. No. 4 gives an idea of the complete arrangement. The water is taken from the well situated close to the engine house, and supplied to the pumps through two pipelines installed underneath the engine house floor. The water is delivered through a common pressure pipeline which is connected to the main pipeline installed in the ground, by means of a vertical descending pipe just behind the distributing piping of the pumps.

The plant described above has the disadvantage that the quantity of water cannot be raised above the normal output of the pump. The latter had, therefore, from the very beginning to be made large enough to deliver the maximum quantity of water required.

Port Arthur, Ont.

The pumping station of Port Arthur, Ont., is a plant which has not this disadvantage. It is provided with pumps which admit of the changing over being done in the most perfect way possible. The current available in this case was also three-phase, 60 cycles, and therefore

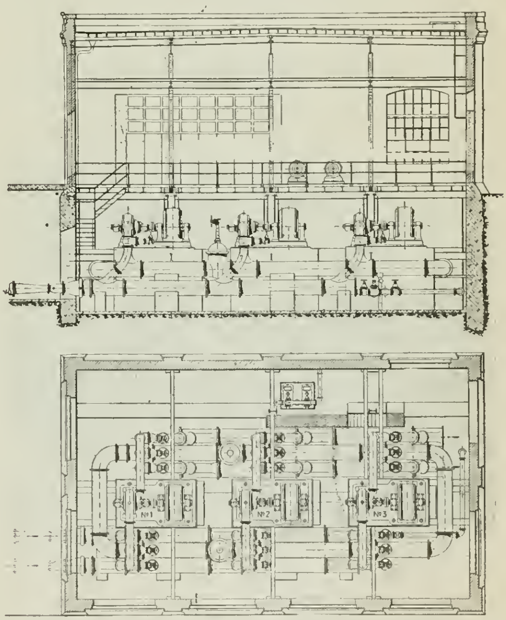


Fig. No. 6.—Plan and Elevation, Port Arthur Pumping Plant

constant speed had to be reckoned on from the very beginning. In order to run the plant as economically as possible, and at the same time to have an ample reserve, three sets of pumps have been installed, each coupled to a synchronous motor running at a speed of 1,200 revolutions per minute and having an output of 270 h.p. These sets are started by special exciter machines, which bring

the pumps up to the necessary synchronous speed. The pumps require, with complete throttling and full speed, only about 35 per cent. of the normal power.

Each pump is calculated for a manometric head of 300 feet and 120,000 Imperial gallons of water per hour.

The general arrangement of the plant is shown in Fig. No. 6. The water enters the pumping station from the water reservoir through two separate suction pipelines, each of 30-inch inner diameter, and is delivered thence to several pumps. In order to have absolute safety in working, should one of the suction pipes have to be repaired, separate distributing pipes lead from each suction pipeline to the pumps, which pipes can be closed by means of sluice valves; the changing over from one suction pipeline to the other can thus be done without interrupting the working of the plant.

The main pressure pipelines are arranged in a similar way. Two pipelines of 24-inch diameter are provided, and the pressure casings of the pumps are connected to same by means of separate distributing pipelines. Thus the change from one pipeline to the other can be made in this case also without interrupting the working. In each of the main pressure pipelines, there is a Venturi meter with automatic recording device. In addition to the above-mentioned pipelines, there is another entirely closed ring pipeline of 24-inch inner diameter, to which both the suction pipes and the pressure pipes of each pump are connected, each pipe having a separate valve. Hence, each pump has, both on the suction side and on the pressure side, a forked pipe with three connecting branches, to each of which a valve is connected.

The above-mentioned ring pipeline is situated between pumps 1 and 2 and provided with a sluice valve, thus enabling the pumps to be used in any combination desired. In normal working this ring piping is not used, as each of

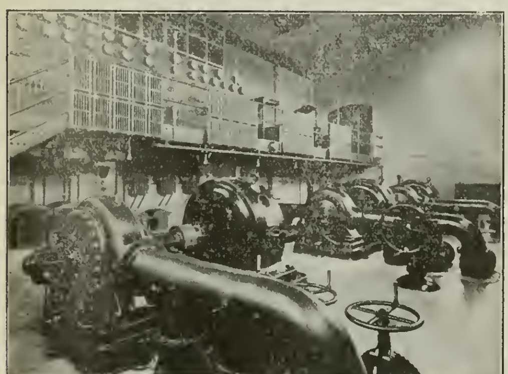


Fig. No. 7.—Interior View of Pumping Plant at Port Arthur, Ont.

the three pumps can be connected to the several suction and pressure pipelines without it. On the other hand, it has to be made use of as soon as the pumps have to be connected in series. It makes it possible for the pumps to be used in any way; for instance, two sets can be connected in series, without the third set being connected up, also no matter which pumps are running in normal service.

Consequently, in case of fire, the normal quantity of 120,000 Imperial gallons per hour can be delivered up to 600 feet by two pumps working in series, leaving the other pump as a spare, should one of the two have to be stopped.

In regular service, the quantity of water for one pump or for two pumps—according to requirement—can be delivered with two or one pumps in reserve, respectively, and, in case of necessity, even the triple quantity of water can be supplied.

As the network of mains to which the pumps are connected is very extensive, and considerable water hammer might arise in case of a sudden increase of consumption, special safety device were necessary. To be on the safe side, the whole system of piping, as also the pumps, was constructed strong enough to sustain the threefold maximum pressure produced when the machines are connected in series. All parts have therefore been subjected to a test pressure of 600 pounds. Moreover, the end covers of the pressure piping in the engine house have been provided with safety valves which permit the water to flow into the discharge piping at a greater increase of pressure.

As the floor of the main engine house of the pumping station is situated below the level of the street, and a considerable depth of cellar was necessary on account of the various pipings, a special pit had to be provided to prevent water accumulating underground. Two sets of small pumps had to be installed for the emptying of this pit.

The rather extensive electric part of the plant has been arranged on a separate platform situated above the ground

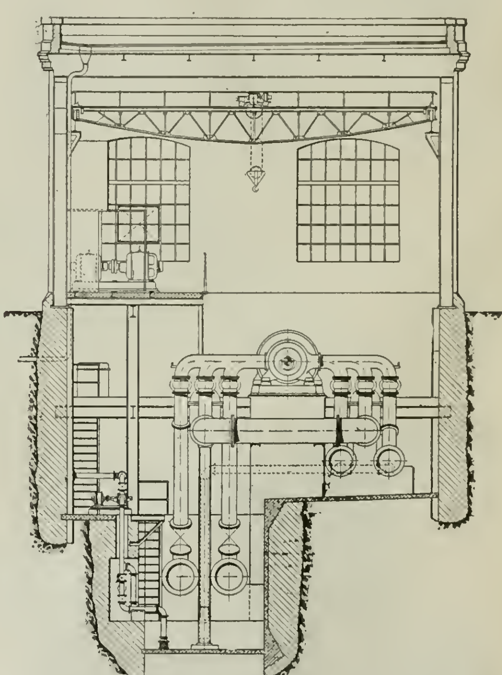


Fig. No. 8.—Cross-section, Port Arthur Pumping Plant

and occupying the whole length of the engine house floor. On this platform are also installed the two exciter sets for starting the main motors. The interior of the engine house is shown in Fig. No. 7. The manner in which the distributing pipings are connected to the pump casings is shown by Fig. No. 8.

ANNUAL REPORT BY CITY ENGINEER OF OTTAWA SHOWS SAVINGS

ANDREW F. MACALLUM, C.E., commissioner of works of Ottawa, has presented his annual report to the Board of Control of that city. The report shows a saving of $105,753 in the operation of the works department during the year 1917, as compared with the preceding year. This figure is computed as follows:—

	Total approximate saving or earnings
Rideau River sewer pipe, $16.400, laying $2,600.00	$ 19,000.00
Parkdale Avenue pavement, surfacing, 10 per cent. for supervision, etc.	580.00
Gloucester Street pavement: Brigham price, $17,886.15; city price, $13,620.00	4,275.00
Melrose Avenue pavement: Contract price, $5,890.00; actual cost, $5,239.00	651.00
Holland Avenue pavement: Contract price, $9,840.00; actual cost, $8,397.00	1,443.00
Asphalt: Imperial, 18.94 per ton, vs. Trinidad, $24.27	4,800.00
Pretoria Bridge approaches, grading: Clarey price, $.85 per cu. yd.; city cost, $.44 per cu. yd.	2,184.00
Street sweepers: 82 in 1916, 55 in 1917	12,400.00
Garbage wagons: Ottawa Car Co., $515.00; city, $249.32	5,313.00
Macadam roadway, spalls, cost $1.50 per cu. yd., concrete	1,125.00
Saving in snow-clearing labor cost due to efficient methods	7,000.00
Two motor flushers, $4,650.00; horse flushers, $3,500.00 = $8,150.00; replacing 20 horse sprinklers, $16,800.00	8,650.00
Amount under estimate on Rideau River sewer work for the season's work, not including pipe	6,900.00
Waterworks saving	31,432.00
Total	$105,753.00

Following are the details of the $31,432 saved in the waterworks branch:—

Engineering staff reorganized and work carried on with staff of four instead of fourteen, Saving in salaries annually	$10,540.00
Cost of power for operation of low-lift pumps at Lemieux Island pumping station reduced	3,415.56
Staff at booster station reduced, saving of	2,059.00
Standby current supplied at the booster station dispensed with, annual saving	7,016.00
Special valve frames and covers re-designed and manufactured now at annual saving of	1,400.00
Staff of tap inspectors and well men reduced, saving	2,184.00
Method of applying chlorine treatment to the water changed, saving in bleaching powder per annum	800.00
Chlorine treatment of water adopted (recommended by Mr. Race), effecting annual saving	3,200.00
Intake pipe sand blasted and coated with a bitumastic solution. Lowest tender received, $1,700.00; work completed by city labor for $882.00; saving	818.00
Total	$31,432.00

Mr. Macallum has always been a very strong advocate of the day-labor system as opposed to private contracting in municipal work, and the fact that he has not yet altered his opinion is shown in the following extract from his annual report:—

"Perhaps the most important event of the year was the competition established by our remodelled asphalt plant against the city contractors. The fact that the city laid the pavement on Gloucester Street at a saving of $4,275.00 under the lowest tenderer's price has already been drawn to your attention. This entry of the corporation into the paving field may be properly classed as another step towards the generalization of day labor on corporation work.

"Another very important feature of the year's improvements was the introduction of the motor-driven flushers. The work of these flushers appears to have met with general commendation and has resulted in Ottawa having, and I say it advisedly, paved streets which compare in cleanliness with any streets in America.

"A still further change which has been of great public benefit is the extension of the road-oiling system. While the flushers were keeping the pavements clean, the oil and tarvia, which were widely applied, gave the city dustless and sanitary macadam streets.

"During the summer, 1.89 miles of asphalt pavement were laid at a total cost of $104,879.84. The department laid pavements on Melrose Avenue, Gloucester Street and Holland Avenue. The detailed statistics follow:—

	Mileage	Contract cost
O'Leary's, Limited, laid Albert St., Laurier W. to Rochester	.20	$ 21,506.25
O'Leary's, Limited, laid Sussex, Rideau to St. Patrick	.31	34,271.83
Ottawa Construction Co. laid Hinton Ave., Wellington to Tyndall	.17	4,740.00
City laid Melrose, Wellington to Bethany	.13	5,939.38
City laid Gloucester, Elgin to Kent.	.43	13,620.90
City laid Holland, Wellington to Tyndall	.16	8,397.00
City resurfaced Parkdale, G.T.R. to Carling	.49	16,403.68
T. G. Brigham laid concrete foundation on Parkdale, G.T.R. to Carling		
Total	1.89 mi.	$104,879.84

"The remodelling of the asphalt plant has resulted most beneficially. The plant as remodelled, while not large enough to permit the city to do pavement work on a large scale, has been sufficiently efficient to allow the city to compete with long-established paving companies. Warren Bros. were awarded the contract for the remodelling of the plant. They commenced work in February and had the plant ready for operation on May 11th. The chief improvements made to the plant were as follows:—

"A new single-drum sand dryer and cold and hot material elevator and Best oil burner, with fittings, were installed. A new asphalt mixer, scales, weighing bucket, flux oil storage and flux oil measuring tanks were also provided. The total cost of the work was $9,217.

"Approximately $30,000 was spent on repairs to permanent pavements. The area repaired was much larger than in 1916, as the city took over twenty-three streets on which the guarantee period had expired.

"The Dominion Bridge Co. commenced the work of re-erection of the Pretoria Avenue Bridge in February and

have now completed all their work. The electrical apparatus was installed late in October and the bridge was successfully operated under electric power on October 30th. The bridge was thrown open to traffic on November 1st. Light standards and safety gates will be provided and installed during the winter months.

"Forty-three sidewalks were laid the past summer at a total cost of approximately $21,000. Their combined length is 3.2 miles, including crossings.

"Last year only 5.87 miles of macadam road were treated with Tarvia dust layer, at a cost of $4,450.58. This year 9.3 miles were treated with Tarvia and refined tar at a cost of $8,260.55.

"In 1916, 7.88 miles of road were sprinkled with road oil. This season 33 miles were sprinkled twice at a total cost of $13,898.56. The second application cost only $5,228.39, as compared with $8,670.17 for the first sprinkling. This was due to the fact that less oil was required for the second application and to the use of new oilers. Two Austin pressure distributors were purchased. These distributors were attached to old street sprinkling wagons and worked very satisfactorily, using less oil and distributing in a more even manner than the old gravity type machines. The elimination of the dust by oiling of streets, besides the convenience to the citizens, has also had a very beneficial effect upon the general health of the community.

"In 1916, eighty-two street sweepers were employed. This year only fifty-five sweepers were hired, although 2¾ miles of new pavements were added to the sweeping areas. Assuming that there are 170 working days in the season, the total saving in wages will be about $12,400. This reduction in the cost of the work is largely due to the use of motor flushers.

"Two 1,200-gallon capacity motor flushers were purchased in April from the General Supply Co. These flushers were operated in two nine-hour shifts daily. The estimated cost for operating, including repairs, was $32 per day, and the actual cost $31. An average of 18 miles of pavements of all widths were thoroughly washed daily at a cost of $1.72 per mile. (The estimated daily average was 20 miles at a cost of $1.60 per mile.) The total cost for operating these flushers for 150 days will be approximately $4,650.

"These flushers replaced twenty of the old horse-drawn sprinkling wagons which, if used regularly, would have cost $16,800 for the season, making a saving of $12,150. The streets were washed cleaner and kept in better condition than ever before.

"The contract for the erection of the corporation workshop at Chamberlain Avenue was let to Alex. Garvock, Jr., for $17,542. This building is nearing completion and will be occupied in the near future.

"A saving of approximately $1,125 was made by using 756 cubic yards of broken concrete from Sussex Street pavement, and Rideau, Albert and Elgin Street walks, as base for new macadam roadways.

"The quality of the city's water has greatly improved, as indicated by the fact that one year ago the city was using 500 lbs. of bleach a day, whereas the dose has been reduced to less than 300 lbs. If not restricted by the Ontario Board of Health as to amount to be used, the dose, in my opinion, could be safely reduced to 200 lbs. per day.

"The water pressures throughout the city show general improvement. Tests taken at various hydrants indicate an increase in pressure of from twenty to fifty-five pounds over tests of 1915.

"An important event of the department's year has been the opening of the overland pipe system. The new system from the start worked very smoothly.

"An important saving in the consumption of water has been made through the medium of our pitometer surveys. The city's consumption has been reduced by over 2,000,000 gallons in twenty-four hours. Since the water is now pumped by electricity, this saving alone represents several thousand dollars a year in current. This Pitometer work has only been started, however, and by next year we hope to reduce the present daily rate considerably."

MOLYBDENUM IN ORES AND CONCENTRATES

The following method of determining the molybdenum in ores and concentrates has been described by H. C. Mabee, chemist of the Department of Mines, Ottawa. Mr. Mabee reports that this method has been in satisfactory use for the past two years in the work of the department: Place from 0.5 to 1 gram of the sample in a quartz or platinum crucible of 50 c.c. capacity, add 2 to 3 c.c. fuming nitric acid, heat gently and evaporate just to dryness. Add 30 grams fused acid potassium sulphate and fuse. Leach out the fusion in hot water, heat to complete solution, precipitate the iron with ammonium hydroxide, settle, filter and wash with hot water. The precipitate should be examined for retained molybdenum and if necessary reprecipitate. To the ammoniacal filtrate add 50 c.c., 1 : 1 sulphuric acid. Pass through a special reductor made of half inch glass tubing, twenty-four inches long, drawn out at the lower end and connected by rubber tubing with a three-inch funnel at the upper end. The reductor is filled with amalgamated zinc the size that will lie on a 10-mesh sieve. The lower end passes through a two-hole stopper and about quarter the way to the bottom of a 1-litre gas bottle. By means of a piece of bent glass tubing passing through the second hole of the stopper, connection is made with a suction pump. Before making a reduction wash out the tube with hot 1 : 1 sulphuric acid solution. Place 20 c.c. of a 15 per cent. Ferric alum solution (made slightly acid with sulphuric acid) together with 20 c.c. "titrating mixture" in the gas bottle into which the reduced solution is passed. Wash out the reductor at least four times with the hot dilute sulphuric acid, filling the funnel each time. Titrate warm with standard potassium permanganate standardized against C.P. Molybdic acid (Baker's 99.9 per cent.) following the same procedure as in the case of an ore.

John Q. Everson, of Pittsburg, gives a graphic illustration of what 185,000 horse-power—the installation of electric drive on a new warship—really means. If the ship were to be pulled along by 185,000 horses, two abreast, the team would be 175 miles long. If such a team were to start from New York, its leading pair of horses would be well beyond Havre de Grace on the way to Baltimore before the vessel it was pulling had left Jersey City.

Canada Foundries and Forgings Company is understood to have had a prosperous year. The company is still operating all its Welland plants to capacity, and operation at this rate has been kept up throughout the year. The Delaney plant recently purchased by the company in Buffalo, has received additional orders for ship forgings, and the earnings have permitted the retirement already of $100,000 bonds, reducing the outstanding issue to $130,000.

WATERWORKS LABORATORIES*

By J. J. Hinman, Jr.
Water Bacteriologist and Chemist, of the State University of Iowa Laboratories for the State Board of Health.

THE waterworks laboratory as an integral part of the up-to-date waterworks plant is so well established and has proved itself so useful that any attempt on my part to justify its existence is unnecessary. It is only where the small size of the plant forbids the expense attached or where an invariable ground water is supplied that the lack of daily laboratory control should be excused. While an experienced operator will probably be able to judge the character of the water supply on most occasions, there are, nevertheless, times when a clear, sparkling water may be carrying large numbers of bacteria, some of which may be pathogens, or disease-producing forms. The only way to know the quality of the effluent is to submit to a laboratory examination. At best the delays incident to our cultural methods are considerable, but to pump a dangerous water until typhoid cases commence to develop in a community before having examinations undertaken is inexcusable. The number of examinations which it is advisable to make will depend, naturally, on the supply. If the supply is from deep wells, fewer examinations will be required than where the supply is from shallow wells and infiltration galleries. Where a polluted water is coagulated and filtered, examinations should be made even more frequently than in the case of the shallow wells and infiltration galleries. It should be remembered that a dangerous water is being treated and that the character of the effluent may change from day to day or even from hour to hour. Then, too, the mere installation of a laboratory does not confer immunity from raw water troubles or even from the more serious difficulties. Under certain conditions there may be considerable daily variations in the nitrogen factors. It is essential that the variable factors be recognized so that changes in the raw water may be detected and the treatment altered to meet the new conditions. More elaborate examinations of the treated water are justified as giving additional evidence as to its satisfactory character. For some time I have been curious to know about the water laboratories which served the various water plants directly. I wanted to know what plants maintained laboratories, how extensive they were, how they were organized, what their routine procedures were and what results were obtained. I sent out a very comprehensive questionnaire to all cities of over 25,000 population in the United States and Canada, as well as to some smaller places where I knew laboratories were maintained or rapid sand filtration plants installed. My percentage of replies was very good. There are only four or five towns of special interest which failed to answer my letters. I have data on an average daily pumpage of more than 3,000 million gallons, of which more than 2,800 million gallons supplying cities and towns of a total population of about 17 millions in 1910, is protected by laboratory control directly under the supervision of the waterworks officials or their superior officers. In the control of the 96 plants which supply the 2,800 million gallons of water daily, 203 laboratory workers are employed. Of these, 95 have the title of chemist or assistant chemist. Many of the others have the title superintendent of filtration or laboratory director, and so on. Some of these men I know have had chemical training. Some are engineers who have picked up the rudiments of water examination and carry on such determinations as are necessary for their plants. The preponderance of one-man laboratories is significant and the variety of the work which must be performed is worthy of notice. In addition to the widely differing subjects of bacteriology, microbiology and chemistry of water, miscellaneous chemical and bacteriological work must be entered into. If the laboratory man is also an engineer, so much the better. I was surprised to see how recently the laboratories listed had been installed. Beginning with the one maintained by the city of New York since 1897 and that of Utica, N.Y., established in the same year, we have a rapidly increasing number of laboratories established during the succeeding 19 years. Six plants with a combined average pumpage of 32.5 million gallons per day are now installing laboratories. Twelve plants with a combined pumpage of 45 million gallons per day have daily examinations made at outside laboratories. The Metropolitan Water District which supplies Boston and some neighboring communities is a State Commission. It maintains its own laboratory and supplies a little more than 100 millions of gallons of water daily. Of the plants reporting, 23 are owned privately, 72 municipally and one by the United States Government. The employees of 29 of the municipally owned plants and those of the government plant are selected by civil service methods. Rivers and streams form the direct source of 68 plants out of the 96 that have their own laboratories; the remaining sources are lakes, impounded waters from more or less satisfactorily protected watersheds, and in a few instances wells and infiltration galleries. Those plants which do not maintain laboratories are nearly all using the water of wells, or impounding reservoirs. None of them supply more than an average pumpage of 16 million gallons per day. One or two pump direct from streams without treatment. The quantity of the laboratory work done as well as the particular determinations made is dependent upon local conditions. For instance, there is very little use in determining iron every day unless the raw water contains that metal in sufficient quantities to precipitate or aid the growth of iron-secreting organisms. Color and turbidity are usually determined on the raw and treated supplies if the water is coagulated and filtered. These factors give us a somewhat rough indication of the efficiency of the treatment. Alkalinity is another common determination since it limits the amount of coagulant which may be put into a water without the addition of alkaline substances such as lime, soda ash or bicarbonate of soda. Free carbon dioxide is carefully watched in some plants—particularly those that soften the water, remove iron, or use the iron and lime process. Incrustants and other matters are determined where the conditions justify.

Periodical Analyses

Occasional complete sanitary chemical examinations are usually considered sufficient, since chemical standards based upon the ordinary factors of a sanitary analysis often mean very little when applied to the routine examination of a treated water. As a matter of fact, the oxidation of nitrogen in one of our rapid sand filters is almost negligible and any evidences of pollution which appear in the raw water will be but slightly modified. This state of affairs has led to error on the part of individuals who have attempted to judge a treated water upon the basis of the commonly stated chemical standards. In the case of stored or impounded waters considerable oxidization may take place and the determination of the nitrogen factors

*Extracted from a paper read before the Iowa Section of the American Water Works Association.

may become of greater importance. Mineral analyses are valuable to users of water for steam-making, but those individual firms who enter seriously into the problem of softening a supply usually make their own determinations of a few important factors. There are quite a few boiler plants in most communities which use proprietary boiler compounds, prepared upon the basis of special analyses by the manufacturers of the compounds or upon the examinations of the laboratory of the water plant. Of course, an analysis of the city water showing its excellence for all industrial purposes is a good advertisement. In general, however, it may be said that a quarterly mineral analysis, a weekly or monthly sanitary chemical analysis and routine determinations of color, turbidity, temperature, alkalinity, free carbon dioxide, free chlorine and similar determinations, ought to meet all demands for chemical examinations. In discussing chemical determinations very little reference to the procedures is necessary since the procedures laid down in the Standard Methods of Water Analysis of the American Public Health Association are so universally followed. Plankton examinations are made by but thirty-two of the plants listed. In many cases they are not necessary. Where water is impounded or stored in open reservoirs, routine plankton examinations are useful in indicating the proper time for copper treatment before odors and tastes due to algae growths have become objectionable.

Standards of Efficiency More Rigid

When working with a treated water, the bacteriological determinations are of the highest importance. In most instances it is they which determine the efficiency and adequacy of the treatment given. The arbitrary standards of efficiency applied to water treatment are rapidly becoming more and more rigid. The original filters which the New Chelsea Water Company of London installed about 1829 were considered efficient, if they merely removed the turbidity of the Thames water. Then, a good many years later came Koch's standard of a maximum of 100 bacteria per c.c. This standard was applied to water of all kinds. Later a standard based upon a percentage removal of bacteria came into vogue. The percentage standard of plant efficiency is not satisfactory because when one is treating a good raw water the product may show a low percentage efficiency and yet actually be of the best quality. On the other hand, when the raw water is high in bacteria the effluent may be high also and still be within the limit set up. For example, 99 per cent. efficiency in the operation of our local plant at one time last winter would have allowed a bacterial count of 8,800 because our raw water had a bacterial count of 880,000. Within the past year or so, Wohlmann, of the New Jersey State Board of Health, has proposed a logarithmic ratio standard which has some advantages. It requires that the ratio of the logarithm of the number of bacteria in the raw water to the logarithm of the number of bacteria in the treated water shall be less than 2.5 to 1. In effect, it requires that as the contamination of the raw water increases, the efficiency of operation must increase at a more rapid rate. This standard undoubtedly has its limitations but it is a convenient device for supervision of operation of a number of plants. At the same time that the strictly numerical bacterial standards of operation have been evolving, other standards based upon the freedom of the water from certain kinds of bacteria, such as the colon bacillus and the sewage streptococci, have been developing also. In our country the sewage streptococci have been worked with but little, while in Europe—particularly in Germany—the validity of our conclusions based upon work on the B. coli has been questioned. I believe, however, that the present European tendency is to place more faith in the B. coli determinations than in the past.

Difference of Opinion

There exists considerable difference of opinion as to the maximum number of bacteria of the colon type which may be allowed in a safe water. The presence of B. coli in one cubic centimetre quantities of the water—except occasionally found organisms—is generally recognized as sufficient to condemn a supply. In addition it has been said that it should be absent from the majority of 10 c.c. samples of the treated water. Constant absence in 5, 10, 50 and even 100 c.c. have been recommended. A few years ago the United States Treasury Department Standard for water supplied to trains carrying passengers in interstate traffic was promulgated. Briefly, this standard required that a water should not contain more than 100 bacteria at 37 deg. C., and that not more than one out of five ten c.c. plantings of the water into lactose broth should show the colon bacillus. This was practically equivalent to setting a limit for colon at one in 50 c.c. This standard was adopted as the majority report of the committee appointed. It aroused considerable opposition from the water men when first adopted, but the government officials explained that it was not intended for city supplies, but for the small amount of water supplied to passengers. Since then it has been required that bottled spring waters should pass this Treasury Department test.

Lack of Uniformity of Procedure

The practical uniformity of procedure in the chemical determinations of a water analysis has not existed in the bacteriological procedures due to the changes and ambiguity which were introduced by the committee into the second edition of the Standard Methods of Water Analysis. The third edition which was published this year (1917) is furnished with a much clearer statement of bacterial methods and no doubt will aid materially to clear away the confusion which exists. In considering the methods used I find least variation in the plating because the possibilities for variation are not so great. In the body temperature determinations some workers use litmus lactose agar (which gives the opportunity of recognizing acid-forming bacteria in addition to the count), others use the plain nutrient agar. At 20 deg. C. many of the older laboratories use gelatine, while others employ agar on account of its lack of trouble with liquifiers and its general convenience. In some laboratories the 37 deg. C. or body count is omitted, while in more laboratories the 20 deg. C. count is omitted on account of the recommendation of committee in the second edition of Standard Methods. Fortunately, the third edition has restored the 20 deg. C. count. In regard to the colon bacillus there is the greatest diversity of method. Some are satisfied with gas formation in dextrose or lactose broth at the risk of calling a considerable number of tests positive when the gas formation is due to other organisms than the colon bacillus. Some prefer lactose bile. Others make confirmatory tests on all gas-bearing tubes. These confirmatory tests vary widely. They may consist in making simple streaks on litmus lactose agar or on Endo's fuchsine-sulphate medium, or they may extend to cultures in a series of sugar media, motility, Gram's stain, and so on and on. The new standard methods have prescribed a method using litmus lactose agar and lactose agar

which will undoubtedly come rapidly into use and enable one to know on reading a report whether any of the two discriminating methods of identifying the colon bacillus have been adopted. The chief business of most of the laboratories is the control of the water supply, but many of them further justify their existence by making examinations of other substances. Where time permits or sufficient assistance is provided, analyses of the chemicals used in the water purification may be examined, as well as the coal, oils and so on. Purchases of these substances under the usual guarantees may be enforced—often at a considerable saving. In city work, food and drug inspection, the milk supply and its inspection, the examination of cement, paving materials, and all city supplies may be perfectly put under the control of the laboratory chief. Where the laboratory men are trained in that line of work, the city laboratory may make the examinations of the board of health's routine. These include specimens of blood for diagnosis of typhoid, sputum for tuberculosis, throat cultures for diphtheria, and so on. Some of the last may be reported from 10 to 24 hours sooner than the state laboratory could report and a difference of this much time sometimes means the loss of a life. I have merely mentioned these possibilities of the extension of the scope of the laboratory to show how it can be made to serve the community in other fields. We, of course, should maintain that the first duty of the water laboratory is to maintain an economical treatment of the water supply which will insure a safe water at all times.

In conclusion, it should be remarked that the practice in the plants which are listed is changing from day to day. In the time that I have been collecting this data, it is inevitable that some alterations have been made. I have endeavored to make it accurate as possible and I believe that it actually represents conditions in the waterworks industry up to the middle of 1917.

EFFECT OF THE WAR ON THE PRODUCTION OF GARBAGE AND METHODS OF DISPOSAL*

By I. S. Osborn

THE effects of the war on the production of garbage and disposal methods are evident from following sources: (1) The decrease in the quantity produced per capita; (2) the decrease in quality or values recoverable by present-day practice; (3) the tendency to change methods of disposal whereby garbage will be utilized.

The decrease in quantity of garbage has been largely due to the increased price of foodstuffs, and the conservation movement which has been started by the United States Food Administration to eliminate food wastes. Up to the present time the increased prices have no doubt had more effect in reducing the quantity than the conservation movement.

A reduction in the quantity of garbage is found in nearly every city, although there are few cases where the quantities have increased this year over previous years. From the studies made by the United States Food Administration, it was found that the results from approximately 60 cities, which reported on the amount of garbage collected, that there was an average decrease of from 12 to 15 per cent., although in some cities an increase is shown over previous years.

The reports show in many cases an excessive decrease, which on an examination of local conditions it is found that less attention has been given to collection, and in many cases garbage has been collected by private collectors for feeding or rendering. On account of the high values of pork, as well as the by-products that can be recovered by reduction, private collectors are more numerous than in former years. No doubt the decrease would have been considerably greater except for the large amount of vegetable wastes going into the garbage pail from home gardens, which were the result of agitation the forepart of the year.

The decrease in the quantity of garbage may not necessarily show a saving made as regards the elimination of food wastes. The amount of grease recovered from the garbage, however, is a better indicator than the quantity of garbage collected.

While the quantity of garbage may not continue to decrease, as this factor is regulated largely by seasonal crops which vary from year to year, or the increased amount of fresh vegetables from home gardens, or an exceptional amount of home canning or preserving, there can be little doubt that the quantity of grease to be recovered from a ton of garbage will continue downward while the present conditions as to foods continue.

The meats are the chief source of grease in garbage. From the data collected during the past nine months, where recoveries of grease from garbage are made, it shows a decrease of 30 per cent. in the amount recovered over the same period during the year 1916, but the actual percentage of grease per ton of garbage shows a reduction of approximately 15 per cent. No doubt there has been a greater reduction in the consumption of meats than was indicated by the decrease in the amount of grease recoverable from garbage. This is evidenced to-day in the purchase of meat at practically every market, where the scraps, gristle, rind, bone, in fact all wastes which were originally trimmed off and sold to rendering companies, are now in the majority of cases pushed off on the purchaser at the price of the edible meat purchased, so that in proportion to the amount of meat that is now purchased, a greater waste is found by the purchaser than formerly. The chief evidence of this is found in the reduced amount of scraps that were formerly purchased by rendering companies, and the shortage of this material in proportion to the total amount of meats sold at the present time.

One of the noticeable features, as regards the change in garbage, is the fact that the greatest change as to quantity and quality is found in what is known as the middle class. This is no doubt due to the fact that the wealthier class have not changed their mode of living on account of the high cost of foods and are able to afford the same at the increased cost. The poorer section, made up principally of laborers, have been in a position to purchase food at the higher prices, on account of the high prices paid for labor and the increased money available.

The middle class, however, have not had a corresponding increase in income comparable with the increased cost of foods.

The decrease in garbage produced will no doubt continue, not only during the period of the war, but several years following, due to the habits that are formed by the people in the preparing or conserving of food, and in the majority of cases there will of necessity be a readjustment of conditions insofar as disposal work is concerned. The disposal of garbage from necessity will change to meet the future conditions.

The methods for the disposal of garbage at the present time can be classified as follows: (1) Burial; (2) dumping; (3) incineration; (4) feeding; (5) reduction.

*Extracted from paper read before the recent meeting of the American Public Health Association

The first two, burial and dumping, are carried on at a low cost, but the only result obtained is the getting rid of the material. The values are lost, and unless proper attention is given they are liable to create a nuisance.

Until recently, there has been a strong tendency towards incineration, especially among the smaller cities. This method, in nearly every case, has been carried on at a considerable expense to the municipality, both for installation as well as operation, with no returns from any source, except in very few cases, where power has been developed, but in the most instances the cost of development has been greater than the revenue obtained.

There is a strong tendency at the present time towards the adoption of other methods of disposal instead of incineration, whereby valuable returns may be made from garbage which would be destroyed. Cities contemplating the installation of incinerators have adopted methods for utilization, and in some cases where incineration plants have been in service for a number of years there is a movement to abandon this practice and adopt methods whereby garbage will be utilized.

Realizing the shortage of materials such as garbage contains, the method of destruction from standpoint of conservation is wrong, although from a sanitary standpoint this method of disposal can be considered one of the most desirable.

Disposal by feeding, or the adoption of piggeries for the disposal of garbage, is a method that will be found desirable in a large number of cities, although in the larger cities no doubt other methods more suitable can be adopted. It is being demonstrated that where proper care is given to this method of disposal very satisfactory results are obtained, and no doubt with more attention given to this method greater advance will be made.

To the average mind the feeding of garbage to hogs is very objectionable, but when ordinary precautions are taken with regard to cleanliness the feeding can be done in a wholly unobjectionable manner, and when conducted properly in a businesslike manner there can be little objection to this method of disposal.

When we realize that from each 1,000 population there is produced waste from the preparation of food sufficient to maintain 25 hogs and develop them to a point ready for the market, it is evident that by this method of disposal one of the greatest economies can be obtained when properly conducted.

With the present price of pork, garbage, when disposed of by feeding, will produce from $7 to $8 in value for each ton.

It is evident from the values that can be obtained from this source that in the smaller cities and communities where garbage can be properly collected and controlled, no other method of disposal will show the same returns from an economic standpoint as the feeding to pigs, and no doubt there will be a great tendency towards the adoption of this method under the present prevailing conditions, as well as the future conditions which are expected.

The method of disposal whereby garbage is reduced and the valuable by-products are recovered in the form of grease and fertilizer tankage no doubt will continue to dispose of the garbage produced from the larger cities and prove to be the most advantageous method that can be adopted under proper conditions. The decrease in the quantity of garbage, as well as the values that can be recovered, will influence to a large extent this method of disposal. There will no doubt, however, be sufficient wastes in the larger communities having sufficient values to warrant the adoption of this method.

The decrease in quantities of by-products to be recovered will to a large extent be offset by the increased values of the by-products, and at the same time there will be a tendency to recover additional by-products not now attempted. There are developments under way at the present time, and equipment being installed whereby additional recoveries besides tankage and grease will be made.

From present indications, garbage will be more valuable for the recovery of by-products than when the grease and tankage were obtained in larger quantities. There is an ever-increasing demand for the tankage produced from garbage for use in the manufacture of fertilizer. A large amount of animal tankage formerly used for fertilizer has been deflected into other sources, so that at the present time there is a great shortage of this material.

There has been objection to garbage tankage as a fertilizer. The price of nitrogenous fertilizer is determined by the available nitrogen. By the old methods of determining the available nitrogen of garbage tankage it was found to be low, but from the actual soil tests made by the United States Department of Agriculture, Bureau of Soils, it was found that the material decomposed readily and afforded a rapid available nitrogen supply. The necessity for the use of all available nitrogenous fertilizer material will make a greater demand and no doubt garbage tankage will be considered equal to other materials for the manufacture of fertilizer.

The values of the by-products produced by the existing reduction plants at present prices will amount to $8,500,000 for grease and $2,250,000 for fertilizer tankage.

From the garbage tankage as produced from all the reduction plants at the present time there can be produced annually about 9,000,000 lbs. nitrogen, 25,000,000 lbs. bone phosphate lime and 2,500,000 lbs. of potash. The grease that is produced is split up into various by-products, the glycerine content being the most valuable. From the garbage grease produced in the plants operating in the United States 8,000,000 lbs. of nitroglycerine can be produced from the recovered glycerine, after which from the grease used for the manufacture of soaps there can be produced approximately 200,000,000 12-ounce cakes of soap.

The amount of garbage that is produced per capita per day is small, but when we realize all the wastes that are produced in this form from the total population the amount is tremendous.

There are two sides to the problem of utilization—its cost to the community and the revenues that can be obtained from utilizations—and when we consider the problem of conservation, even if there were no revenues, it is desirable to utilize all valuable elements which otherwise would be wasted.

There is a great shortage of the materials that can be produced from garbage. It is not a question of profit; every community should utilize its wastes and make available from this source everything possible for the country's needs.

The food problem will not end with the war. The conservation of food will always be necessary—the shortage of fats and fertilizer will remain a problem for years to come, and the installation of proper methods for the utilization of garbage will not only contribute to help under present conditions, but remain a permanent benefit for future years. The public will not soon forget the present lessons being taught in economy. The effects of this will remain long after the necessity has disappeared, and no doubt the people will never again waste so much through the medium of the garbage can as they have in the past.

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Principal Contents of this Issue

LAKE OF THE WOODS REPORT

After five years of research and deliberation there has now been issued simultaneously, from Ottawa and Washington, the final report of the International Joint Commission relating to the official reference respecting the Lake of the Woods levels. The report makes a book of 261 pages, 7 inches by 10 inches, and contains many interesting illustrations. The actual report occupies only 62 pages, but there is a large supplement dealing with such subjects as physical conditions, historical data, boundary questions, agriculture, lumber, mining, fisheries, and navigation.

The book also contains a statement by United States Commissioner James A. Tawney, which is called "Supplemental Conclusions and Recommendations to the Final Report." This supplementary statement is concurred in by the other two United States commissioners but not by any of the three Canadian commissioners.

The International Joint Commission is to be congratulated that its members have been able to agree unanimously upon practically all of the international and engineering problems involved in a reference of such magnitude and importance. The national, provincial, state, corporate and private interests concerned in the Lake of the Woods dispute are so vast, varied and conflicting, that it is only natural, perhaps, that there should be some minor points in regard to which all the commissioners cannot fully concur. These may be left to international diplomacy to adjust.

That the International Joint Commissioners have not been entirely unanimous in regard to all points, shows that a commission composed of an equal number of members from each of two countries, cannot always be relied upon to settle finally all international problems.

The findings of the commission are accompanied by the arguments upon which they are based, these arguments in turn being supported by all the essential information collected by the commission. The whole presentation is logically arranged in such manner that the argument can be readily followed even by a layman.

The physical and other pertinent information accompanying the report, leaves no doubt that the commissioners had all the facts upon which to base a proper conclusion. The report of the consulting engineers, upon which the commission base their conclusions respecting the physical aspects of the case, has already been reviewed in *The Canadian Engineer*.

It is a matter of satisfaction to find in the supplement of the report such a complete description of the physical conditions of the watershed, its early history and its requirements as regards travel, agriculture, lumber and power development. The future possibilities of the district are clearly indicated. This supplement forms the most concise, yet complete, historical sketch of the district,—embracing a large extent of territory on both sides of the boundary,— that has yet been published.

When the eight pages of bibliography are noted, one is impressed with the comprehensive character of the records which the commission had at its disposal and evidently reviewed during the course of its work on this reference.

The United States commissioners did not wholly assent to the system of supervision and control recommended in the report, although they have signed the report. Upon this point *The Canadian Engineer's* views were clearly set forth in the editorial on "Control of the Norman Dam," in the issue of November 16th, 1916, in which it was stated that after the commission has designated the highest and lowest levels to be permitted in the Lake of the Woods, the Dominion Government (either directly or co-operatively with the Ontario Government), undoubtedly, would be prepared to give assurance that the specified levels would be maintained and that the dam would be operated according to such findings of the commission as might be acceptable to both governments.

The actual physical control of the Norman Dam and other Canadian structures situated wholly in Canada, must be left to Canada. The Dominion will no doubt pledge itself to carry out the findings of the International Joint Commission, but the physical means of making them positively effective are matters of national, and not international concern. If by anyone's fault, the Dominion were to fail to live up to its obligations, it would be responsible not only to the United States, but also to all private and corporate interests concerned.

The government of the Dominion of Canada is surely a responsible business concern which can be relied upon to carry out its contracts without the necessity of personal supervision by party of the second part.

PROSPERITY OF WAR

War, as we have seen, has promoted increased activities in the Dominion, but, as recently pointed out by Mr. C. W. Barron, the well-known Boston publicist, wealth is not made by prices or wages. The wealth of a nation is from its production in quantity. The farmer is

rich with well-tilled lands, strong cattle and well-filled barns. He is no richer when we double the price for his lands, his cattle or his products, because in the end he has to pay double prices for his labor and everything he consumes or uses. "The great danger in Canada and the United States to-day and one militating against our prosperity, is that the war in Europe has been marking up prices for labor and commodities in America and we have been thinking ourselves rich. To make an analysis of the prosperity that is to come to Canada during and after the war we have got first to ascertain the amount of energy Canadians are going to put into this war in the way of production, in the way of labor, in the way of sacrifice, in the way of savings. The fictitious prosperity of the present is high wages, increasing consumption rather than high wages adding to savings and increasing the national wealth. Next after the energization of the people as a basis for war prosperity comes the savings. "A nation that earns and spends is not going ahead; a nation that earns and saves can own the earth," said Mr. Barron, adding: "The third fundamental for prosperity from the war is in the one word 'organization.' This must comprise union and efficiency. If we become a nation of spendthrifts, eating more, wearing more, and playing more because our neighbors are in distress and we get more for what we have to sell them, we shall be laying the foundation of a tremendous smash when we meet the stern reality of competition after the war, when the 50,000,000 men now at war become competitive producers with us, and we have become soft and luxurious."

ENCOURAGEMENT OF CAPITAL

The Canadian government will not antagonize the means necessary to the development of natural resources in Canada. This is very important as chiefly by the active development of our resources will we be enabled to pay the heavy interest charges on the rapidly increasing national debt. Just before the recent Dominion election, Premier Borden in a public statement said that capital in the Dominion will not be taxed at any higher rate than is imposed by the United States government as the war progresses. The tax on incomes will be increased at the next session of parliament so as to coincide with the last income tax amendment of the United States government.

The levy upon business profits, which now takes a portion of net profits above 7 per cent. until three-quarters of all above 20 per cent. is absorbed by the public treasury will be re-enacted at the first session after the Union Government meets. There was on this point some doubt in the utterances of the finance minister, many corporations retaining the impression that the tax on war-time profits might not be carried beyond 1917. The prime minister has stated definitely that it will.

The packing houses will not be allowed to retain a profit in excess of 2 per cent. upon the annual turnover. In the United States this is 2½ per cent. The packers may retain only 7 per cent. on their invested capital free from tax. Between 7 and 15 per cent. the State takes one-half and in addition to that a 1 per cent. extra tax is pared off the company's residue of 11 per cent., reducing any packer's profits to a maximum of 10 per cent. Over and above 15 per cent. all packing house profits are absorbed by the State.

The finance minister has made reassuring statements regarding taxation, on behalf of the government. In July last, he stated that any taxation to which it might be necessary for the government to resort from time to time would be in accordance with legitimate and established forms of taxation sanctioned by the tradition and experience of British self-governing communities. In February, 1916, Sir Thomas said, during the course of his budget speech: "Canada is a country inviting immigration, and we must be careful not to create the impression that it is likely to become a country of heavy individual taxation. In this connection, I think it opportune to state on behalf of the government and as enunciating its settled policy, that in providing our war expenditure, resort will not be had to taxation upon the farms, personal effects or incomes of those engaged in our great basic industry of agriculture."

PERSONALS

W. D. Cowan, newly elected Union candidate for Regina, is an associate of the Saskatchewan Branch of the Canadian Society of Civil Engineers.

Arthur J. S. Hawken has been appointed Ontario representative of the Dominion Paint Works, Limited, with headquarters in the Lumsden Building, Toronto.

Donald C. McGregor, Dalhousie, has been appointed research assistant in the chemistry department, University of Manitoba, under the Advisory Council on Research.

W. C. Hawkins has been elected president of the Southern Canada Power Company, Limited, of which he was already a director. Mr. Hawkins is managing director of the Dominion Power and Transmission Company, of Hamilton, Ont.

Col. Robert S. Low, who is chairman of the Reconstruction and Repair Committee at Halifax, is the managing director of Bate, McMahon & Co., general contractors, of Ottawa. Col. Low has built most of the military camps in Canada, including Valcartier, Hughes and Borden Camps, and many others. He has appointed Hamilton Lindsay, of Liverpool, N.S., as his chief assistant in the work of reconstruction.

Lieut. John S. Galbraith, who has been awarded the Military Cross, is a B.A.Sc. of the University of Toronto, class of 1913. He was subsequently on the staff in Applied Science until he enlisted and was attached as adjutant to the 123rd (Grenadiers) Battalion. After serving as instructor with the Engineers at Valcartier Camp, he went to England in April, 1917, crossing to France with the Pioneers. Lieut. Galbraith is a son of the late Dean of the Faculty of Applied Science.

Lieut.-Col. Myla M. Betts, who enlisted originally as a private in the Inns of Court O.T.C., London, England, and was gazetted a lieutenant with the Cheshire Regiment, being transferred later to the Royal Engineers, with the rank of captain, and prior to this last appointment was staff D.A.Q.M.G., has been graded assistant director-general of transportation. Lieut.-Col. Betts graduated from University College in 1907, and took his B.A.Sc. the following year.

VICTORIA BRANCH, CAN. SOC. C.E.

The annual meeting of the Victoria branch of the Canadian Society of Civil Engineers was held in the club

room, 610 Belmont House, Wednesday evening, December 12th, and the following officers were elected for the ensuing year:—

Chairman, R. W. Macintyre; vice-chairman, R. Fowler; secretary, E. G. Marriott; treasurer, E. Davis; additional members of the executive committee, W. K. Gwyer and E. P. McKie; auditors, F. C. Green and C. Hoard.

A financial statement for the current year was presented by the auditors, J. B. Shaw and L. W. Toms, showing that the branch finances are in a satisfactory condition. The executive committee reported that they had invested one hundred dollars in a Victory Loan bond on behalf of the branch, and also that twenty-five dollars had been forwarded to Montreal for the tobacco fund for members overseas. It was unanimously resolved that a further sum of twenty-five dollars should be donated to the widows' and orphans' fund.

WATER POWERS OF CANADA

With coal at a high price and the prospect that we shall soon have to depend largely on our water-powers for heating our houses and running our railways, a reliable estimate of what our water-power resources are is of great value, says the Commission of Conservation. The first estimate of this kind was published in 1911 by the commission. Since then, it has conducted water-power surveys of British Columbia, Alberta, Saskatchewan and Manitoba, and has secured additional data on the powers in other provinces. It now submits the figures below as being the latest available:—

Province.	*Total possible h.p.	Developed h.p.
Ontario	5,800,000	760,000
Quebec	6,000,000	640,000
Nova Scotia	100,000	26,000
New Brunswick	300,000	15,000
Prince Edward Island	3,000	500
Manitoba		76,000
Saskatchewan	3,500,000	10
Alberta		33,000
Northwest Territories		Nil
British Columbia	3,000,000	250,000
Yukon	100,000	12,700
Total for Canada	18,803,000	1,813,210

*The figures in this column are given with much reserve since it is practically impossible to arrive at exact amounts for any country. In addition to detailed surveys and flow records, such factors as artificial storage, economic head to be developed and kind of industry to be established all vary the estimates for each individual site.

Orders were issued from Washington recently that no new war contracts shall be placed in Buffalo before the War Industries Board certifies that there is power sufficient for their manufacture. Formal assurances have been given Canadian authorities that approximately 100,000 electric horse-power imported from Canada will be used only for manufacturing war products. Plans are being worked out by the War Industries Board, some of which already have been put in effect in Buffalo, by which there will be a redistribution of available power so that industries regarded as of lesser importance to the war programme shall receive their power at times when it is not needed by concerns working directly on war orders. To some extent also the amount of power received by these industries of less importance, numbering about 110, will be curtailed, but it was made clear that this was being done in order that the whole city might benefit. The Canadian authorities were unwilling that the power companies on their side of the river should sell current to American factories not engaged in war work when Canadian factories were not receiving all the power they needed. It is planned also to ask industries in Rochester, Syracuse and other cities, which now receive current from Niagara Falls, to cut down on their use of current so that Buffalo war industries will have more.

Coast to Coast

Montreal, Que.—The annual meeting of the Crown Reserve Mining Company, Limited, will be held January 23rd.

Montreal, Que.—The Dominion Bridge Company has taken new contracts for marine engines and boilers to the amount of $1,170,000.

Montreal, Que.—The federal government of the United States have issued an order to the Hydraulic and Niagara Falls Power Company releasing between 80,000 and 100,000 electrical horse power. Electro-chemical companies working on important war orders will receive power diverted from plants engaged in the manufacture of non-essentials. There will be a general scaling down of the power received by the latter and in some instances large concerns will be cut off entirely. The two power companies are now producing a total of 278,000 horse power, about 40,000 of which has been coming to Buffalo.

Niagara Falls, Ont.—Mr. C. A. Windner, president of the Niagara Falls, N.Y., Rotary Club, speaking at a recent dinner given to the Buffalo Rotary Club, on the power-production of Niagara Falls, said:—"The engineering corps of the United States had perfected plans to increase the production by 1,000,000 horse power. The plan contemplated is similar to the Ontario Hydro power canal, taking the water from the river at La Salle and diverting it to Lewiston through a tunnel, and there turning it into the turbines which would produce the power. The advantage of this system is the drop of 324 feet between La Salle and Lewiston." Windner said that "the plan had progressed so far that an additional 20,000 horse-power could be secured in a year, and 20,000 additional each month until the 1,000,000 total had been reached."

Ottawa, Ont.—A summary of the railroad rate-raising judgment handed down by the Board of Railway Commissioners, says:—"Subject to the limitation of the Crow's Nest Pass agreement, and to the specific limitations contained in the judgment, freight rates are permitted to be increased, in general, approximately 10 per cent. in the West and 15 per cent. in the East. While the Grand Trunk Pacific and the C.N.R. are not included in this agreement, they are to be treated as if included. A 15 per cent. increase west of Port Arthur and a 10 per cent. increase in the eastern balance of the through rates is permitted, subject again to the limitations of the Crow's Nest agreement. On coal an increase of 15 cents a ton is allowed, and on clay, sand, gravel and crushed stone, 5 cents. On grain to Lake Superior ports an increase of two cents per 100 pounds is allowed. Grain and grain products, etc., in the West, other than for movement to Fort William, and also on the movement of these from Fort William east, are permitted an increase of 15 per cent., subject to a maximum of two cents per 100 pounds. Lumber rates in the West are also granted maximum increases from 3 to 5 cents, according to distance from British Columbia. Transcontinental class rates may be increased 10 per cent. No increase allowed in transcontinental commodity rates. In British Columbia an increase of 10 per cent. on freight rates is allowed; no rates to be lower than the Prairie rates as increased. No increase in passenger rates is allowed in British Columbia."

Princeton, B.C.—The work of driving the big 4,000-foot tunnel is proceeding at the rate of eighteen feet a day, and will proceed at the rate of twenty-one feet a day when solid ground is entered. The tunnel measures 9 x 11 feet in the clear.

Quebec, Que.—The first passenger train to cross the Quebec Bridge will be the I.C.R. local from Quebec to Montreal, leaving Quebec January 6th next. This is official.

Vancouver, B.C.—The city is petitioning the government for the erection of a steel plant. It has been stated that at least $5,000,000 would be required to place a plant of this character in operation.

Vancouver, B.C.—The first engine made in British Columbia to be installed in a munitions boat is under construction in the Wallace Shipyards.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Mount Pleasant Road Bridge, Toronto

Reinforced Concrete Structure Consisting Essentially of a Pair of Cantilevered Beams of Arched Form, with Free Joint at Center — Piers and Abutments on Skew, Parallel to Railway Track

By J. S. BURGOYNE

Designing Engineer, Department of Railways and Bridges, City of Toronto

THE extension of Mount Pleasant Road from the Toronto city limits southerly across Mount Pleasant Cemetery to Home Avenue will relieve the growing congestion of traffic on Yonge Street and later take care of the future communication requirements of North Toronto. This new artery runs parallel to and about half a mile east of Yonge Street. This civic improvement necessitated the construction of a bridge over the ravine and the Grand Trunk Railway (old Belt Line) at a location just south of Merton Street.

The south approach to the bridge is an earth ramp through the cemetery on a 3 per cent. grade, while the north approach consists of a timber trestle between the concrete structure and Merton Street and earth fills to the north, east and west.

In order that the grade of the north approach should strike Merton Street with as little difference in elevation as possible consistent with the maximum allowable of 5 per cent., it was thought advisable to use an easy vertical curve over the centre span from the ends of which straight

Fig. No. 1.—General View of Bridge, Looking East from Belt Line Tracks

grades were provided, 5 per cent. for the north approach and 3 per cent. for the south. When this improvement as a whole is completed the north approach grade will run out about 500 feet north of Merton Street, which will be raised about 6½ feet at the intersection with 4.8 per cent. grades east and 3.8 per cent. grade west.

Owing to the fact that the railway track is at an angle of 73° with the centre line of the street, it was deemed advisable on the score of economy to place the piers and abutments on the skew, approximately parallel to the railway right-of-way. The central span was thus reduced to a minimum.

Alternative plans for this structure in steel and in reinforced concrete were prepared and tenders received for the two types of construction. The contract was finally awarded for the construction of a reinforced concrete bridge.

The bridge proper, as will be seen from Fig. 4, consists of a central span providing a clear track allowance [illegible] feet in width and a standard vertical clearance of 22 feet 6 inches for the old Belt Line railway. The southerly span provides 24 feet clear for a future roadway in the cemetery, and a similar span to the north crosses the small creek parallel to the track.

This skew in the bridge, while to a certain extent increasing the difficulty of form work and consequently also the cost thereof, effected a substantial saving in the amounts of concrete and steel which would have been required had the piers and abutments been placed at right angles to the centre line of the bridge, while at the same time the appearance of the structure as a whole was not materially impaired.

The deck of the bridge provides a roadway 40 feet between curbs with two street railway tracks having a 4-foot 4-inch devil strip in the centre, and two 7-foot sidewalks.

The General Specifications of the Ontario and Railway Municipal Board govern the loading and the allowable working stresses used in the design, which are briefly as follows:—

For the electric railway, two 40-ton cars; for the roadway, one 20-ton road roller or one 12-ton (loaded) motor truck and 135 lbs. per square foot for otherwise unoccupied roadway; for the sidewalks, 100 lbs. per square foot.

For 1:2:4 concrete: Compression in beams, 600 lbs. per square inch; compression in columns, 500 lbs. per square inch; shear, 40 lbs. per square inch.

For reinforcing steel: Compression or tension in beams, 15,000 lbs.; compression or tension in columns, 10,000 lbs.; maximum shear, 1,000 lbs.; modulus of elasticity, 30,000,000 lbs. Bond stress, 60 lbs. per square inch, equals 65 diameters for plain, round rods.

As will be noted by an inspection of the general plan of the structure, shown herewith (Fig. 4), the general outline gives the casual observer the impression of an arched bridge. In reality, however, as appears upon examination the longitudinal section through the centre of the bridge, the design is that of a span of cantilevered beams supported on piers and enclosed at the abutment ends. This adaptation of the cantilever principle has two distinct advantages, *viz.*, economy of material and vertical pier loads; in this case the load on the the foundation being less than two tons.

This is a new type of structure for Toronto, though several bridges of similar design have been built in the United States in recent years.

As previously stated, the structure consists essentially of a pair of beams, each cantilevered over a pier and anchored at an abutment. The joint where the ends of the cantilevers meet is free insofar as the concrete is concerned. The longitudinal rods, however, project from one cantilever into the other for a short distance, bond, however, being prevented by tar-paper wrapping. The function of these rod extensions is to take care of any local inequalities resulting from the passing live loads at this point.

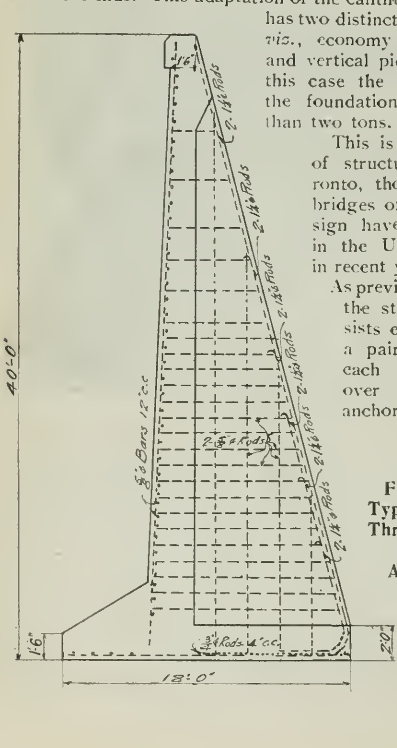


Fig. No. 2. Typical Section Through Wing Wall of Abutments

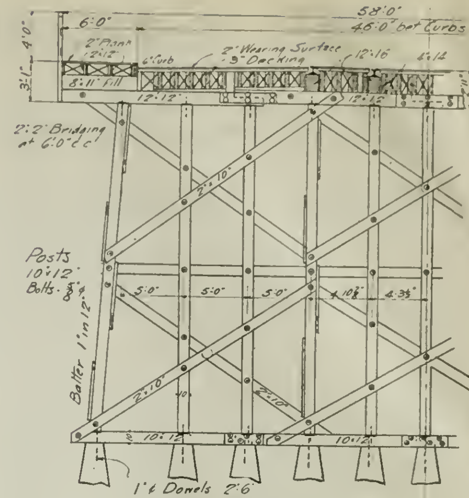


Fig. No. 3.—Typical Trestle Bent
(Half Bent Shown)

The arched beam between the abutment and the pier is 36 inches thick at its centre, being reinforced with 1-inch diameter round rods, spaced 4½ inches centre to centre in the bottom and 1¼-inch diameter rods spaced 4½ inches centre to centre in the top.

The top reinforcing rods are continuous over the pier to the end of the cantilever, two-thirds of the rods being bent down near the end to provide for shear. At the abutment or anchor end of the beam the top rods stop at intervals, one-third of the number continuing a certain distance down the back of the abutment to provide anchorage, as shown in Fig. 4. Of the bottom reinforcing rods it will be observed that one-third of the number extend into the pier and abutment while the remainder are bent up at intervals to provide for shear stresses.

The pier reinforcement consists of ⅝-inch diameter rods, spaced 2 feet apart vertically and 4 feet longitudinally, to provide against surface cracking due to contraction.

The pier footings are reinforced with three ⅞-inch diameter rods longitudinally on each side and ⅞-inch diameter rods at 6-inch centres transversely.

The main sections of the abutments are designed as reinforced slabs supported against the pressure of the earth fill by the floor of the bridge on top and the footings at the bottom.

The north abutment varies in effective thickness from 50 inches at the bottom to 32 inches at the top, and is reinforced vertically with 1-inch diameter rods 4 inches centre to centre.

The south abutment has an effective thickness of 34 inches throughout and is reinforced vertically with 1-inch diameter rods spaced 6 inches centres, both abutments being reinforced longitudinally by ½-inch rods spaced 24 inches centres.

As will be noted (see Fig. 4) the footings are of the standard spread type and are reinforced as mentioned above.

The wing walls of both abutments are of the counterfort type. Fig. 2 is a section through the east wing of the north abutment. This sketch is typical of all the wing walls.

For the section shown the counterforts are spaced 10 feet apart and taper from 10 feet deep at the bottom to zero at the top. They are 24 inches in thickness and are reinforced along the outer edge by 1¼-inch diameter rods varying in number from ten at the bottom to two at the top. These rods are bent at their bottom ends and carried into the longitudinal slab for anchorage. In the body of the counterfort ⅝-inch rods in pairs are spaced as shown.

The bottom slab, forming the heel of this part of the wing wall, has an effective depth of 22 inches and is reinforced longitudinally with ⅞-inch diameter bars spaced 4 inches centres. The vertical slab varies in effective thickness from 32 inches at the bottom to 16 inches at the top, and is provided at the top with a frost batter running down to a depth of 4 feet. The reinforcing of the vertical slabs consists of ⅝-inch rods spaced 1 foot horizontally and 2 feet 6 inches vertically.

The 4-inch sidewalk slabs reinforced with 3:9:25 steelcrete are supported upon brackets spaced 6 feet apart and cantilevered out from the main deck slab to which they are securely anchored. These brackets are 9 inches thick with an effective depth varying from 9 inches at the outer end to 22 inches at the point of juncture with the superstructure proper. The tension reinforcement consists of three ¾-inch diameter rods and the compression of two 1½-inch diameter rods. The balustrade is carried between brackets on a reinforced beam which forms its base.

The balustrade shown in the general sketch (Fig. 4) was that originally designed, but the design was later changed and the hand-railing constructed, as shown in Fig. 1.

The timber trestle (forming the temporary north approach) consists of framed bents spaced 13 feet centres supported on concrete pedestals.

The pedestals rest on a continuous footing 18 inches thick and 36 inches wide which serves in distributing the load uniformly over the foundation.

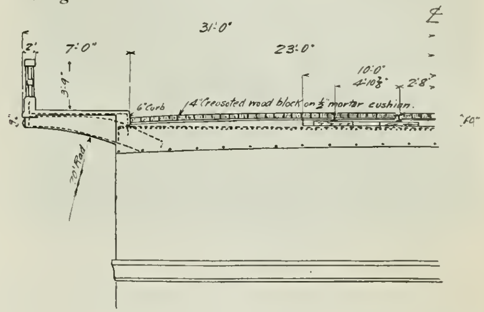
Fig. 3 shows a typical trestle bent. It is composed of eleven 10-inch x 12-inch posts with 10-inch x 12-inch sill and 12-inch x 12-inch cap, braced transversely with 2-inch x 10-inch and longitudinally in pairs joining towers with 3-inch x 10-inch timbers. The sill is anchored to the concrete pedestals by 1-inch diameter dowels 2 feet 6 inches long.

All posts are dowelled to cap and sill by 1-inch diameter dowels 8-inches long and all bracing connections are made with ⅝-inch diameter bolts with cast-iron washers.

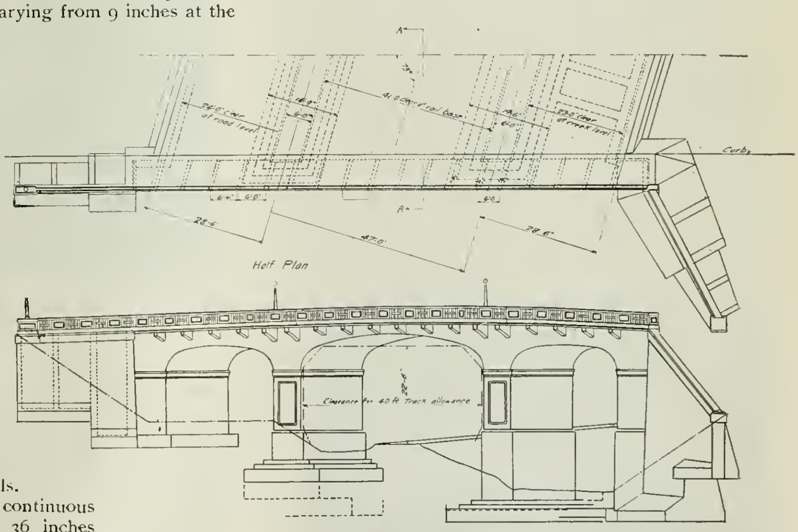
The car tracks are carried on 12-inch x 16-inch timbers, one under each rail and the roadway stringers consist of 4-inch x 14-inch timbers spaced 1-foot 3½-inch centres.

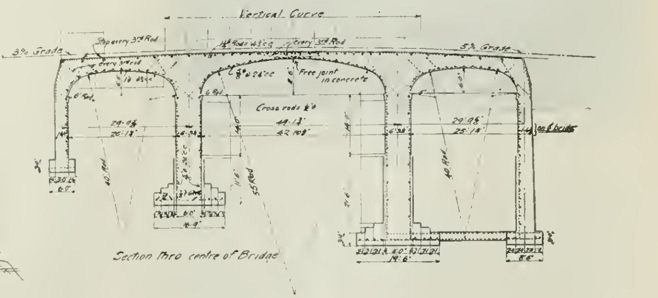
The roadway decking consists of a 2-inch wearing surface superimposed upon a 3-inch underdeck.

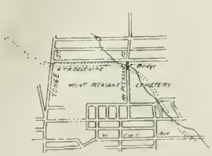
The sidewalk is carried on 2-inch x 12-inch stringers spaced 1-foot 11-inch centres and is composed of 2-inch planking.



Cross Section AA







Key Plan

Fig. No. 4.—Half Plan, General Elevation and Longitudinal Section

The hand-rail upon the trestle is made up of 4-inch x 4-inch posts 6-foot 6-inch centres, two side rails 2 inches x 6 inches and a top rail 4 inches x 4 inches.

Fig. No. 5.—Bridge Site at Start of Work

Bridging, 2-inch x 2-inch, is used at intervals of 6 feet 6 inches across the width of the floor for the purpose of securing additional rigidity.

Construction

For the concrete aggregates the following materials were specified and used:—

Sand.—Sand shall consist of particles, graded from coarse to fine, of sizes that will pass, when dry, a screen having one-quarter inch diameter holes; not more than 20 per cent. shall pass a sieve having fifty meshes, and not more than 4 per cent. shall pass a sieve having one hundred meshes per linear inch. It shall be of hard silicious material, clean, free from dust, soft particles, vegetable loam or other deleterious matter.

Broken Stone.—All broken stone shall be clean crushed granite, trap or limestone of approved hardness and toughness, free from dust, dirt and other deleterious matter. It shall have a uniform, even gradation of particles between the sizes specified.

Fig. No. 6.—Tower and Chutes; Dredging Outfit Shown at Left

Class A: For piers below the springing line of arches, and for pedestals—From a size that will pass through a ring 2¼ inches in diameter to a size that will be retained upon a screen of ¼-inch mesh.

Class B: For sidewalk and curbing veneer layers, sidewalk balustrade and lower 2 inches of slabs—Crushed granite or trap rock of approved color or colors from a size that will pass through a screen of ¼-inch mesh to a size that will be retained upon a screen having 100 meshes per linear inch.

Class C: For all portions of the work not included in Classes A and B—From a size that will pass through a ring 1 inch in diameter to a size that will be retained upon a screen of ¼-inch mesh.

Crushed stone having more than the following content of objectionable material will be rejected: (*a*) More than 1 per cent. of earthy or clayey matter; (*b*) more than 10 per cent. of fine stone or stone dust of less size than minimum given in the above grades; (*c*) more than 5 per cent. of soft stone.

In case of the above defects occurring in combination, the percentages will be modified as the engineer may direct.

Reinforcement Metal: Reinforcement material shall fulfil the chemical and physical requirements of the Standard Specifications of the American Railway Engineering Association. No so-called re-rolled material will be accepted.

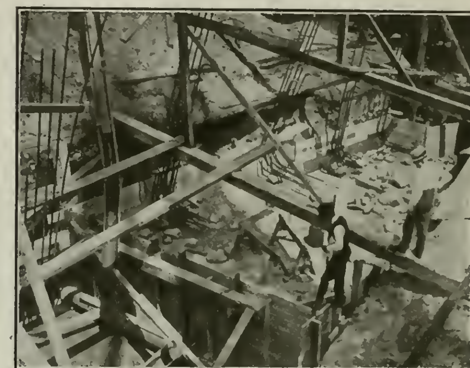


Fig. No. 7.—Footing of West Wing of North Abutment; Reinforcement Rods for Counterforts

Bent rods shall be bent true to dimensions, and when required by the engineer shall be bent to templet.

All reinforcement material shall be free from rust, loose scale, and other coatings of any character, which will reduce or destroy the bond between concrete and steel.

Specifications for the mixing, placing and finishing of concrete were in part as follow:—

The ingredients of concrete shall be mixed in an approved machine of the batch type. They shall be thoroughly mixed to the desired consistency by revolving in the mixer not less than one minute after all the ingredients have been placed in the mixer, or longer if required, to thoroughly distribute the cement and render the mixture uniform in color and homogeneous.

The degree of consistency or wetness shall be as the engineer may direct; but, in general, it shall be wet enough to be poured from the mixers or the wheelbarrows, and to settle into place without being rammed, although it may require to be spread with a spade.

Concrete, after the completion of the mixing, shall be handled rapidly to the place of final deposit, and under no circumstances shall concrete be used that has partially set.

Before concrete is placed in the forms they shall be thoroughly wetted (except in freezing weather) to fill all the pores of the wood. Oil shall not be used for this purpose.

In all piers and abutments, when required by the engineer, all joints between layers shall be bonded by the embedding of approved hard stones of one-man size in the concrete of the lower layer. These stones shall not be placed nearer than the width of a man's foot to each other or to any face of the piers. All embedded stones shall have the concrete placed first, and shall then be embedded by being forced down into the concrete mass an amount equal to one-half their size.

The sidewalk surface was specified as follows:—

The surface veneer layer shall consist of a layer 1 inch thick composed of 1½ parts cement, ½ part hydrated lime, and 2 parts crushed granite screenings; the last shall be specified under "broken stone" Class C.

All exposed surfaces shall be finished by wet-rubbing to an extent sufficient to produce a fine-grained paste covering the entire surface. Immediately upon the completion of the rubbing this paste must be brushed with a wet whitewash brush to form a thin, even coating upon the

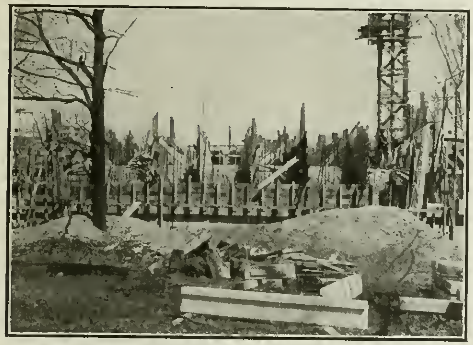


Fig. No. 8.—Forms in Place for Alternate Sections of Superstructure

surface of the concrete. This method has been found to give a finish of a lighter and more uniform color than by the ordinary wash finish with cement grout, probably for the reason that the paste formed from the rubbing is of the same color and composition as the body of concrete.

Excavation for the footing of the piers and abutments was done by clam-shell, horse scraper and by hand labor.

When the excavations had been made the foundation proved to be a dense cemented gravel, so that good bearing value was secured without the use of piles. The soil pressure from piers and abutments is in no case in excess of two tons per square foot and generally less.

The specification for forms in part was as follows:—

Sheathing for forms shall not be less than 1¼ inches in thickness. The face forms shall be of sound, straight, tongued and grooved sheathing, accurately matched and planed smooth on side next the concrete.

The sheeting or lagging of all curved slab centering shall be narrow, accurately matched, tongued and grooved, and planed smooth on the side next the concrete. Joints shall be close-fitting, and all uneven joints or other irregularities shall be planed off. The lagging shall be rigidly supported upon the falsework.

All lagging and timbering of main slabs shall be thoroughly saturated with water prior to commencing the construction of the slabs, and shall be kept so saturated until the concreting of the deck slabs and floor system is completed, and shall then be permitted to dry out gradually as a means of slowly relaxing their support.

Fig. No. 9.—Falsework and Centering for Arched Superstructure

The roadway and sidewalk surfaces were waterproofed under the following specification:—

The concrete surface when thoroughly cleaned of dirt, loose concrete or other foreign material, shall be first covered with a coating of approved asphaltic material to bond the overlying waterproofing material to the surface of the concrete. Upon this shall be applied two ply of 8-ounce burlap, two ply of heavy asphalt felt and a course of asphaltic mastic; the latter to be not less than 1 inch in thickness. The burlap and felt shall be carefully laid in alternate layers and in such a manner as to permit the layers to break joints and shall be free from folds or pockets.

Between each ply of fabric and over the top surface of same there shall be applied a coating of approved water-

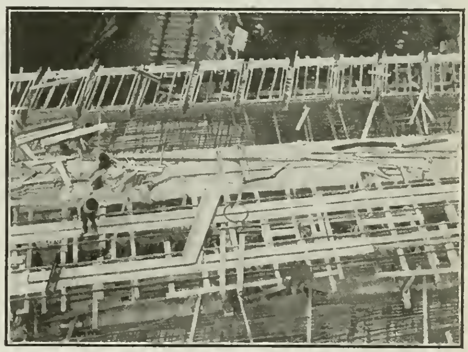


Fig. No. 10.—Aviator's View of Partially Completed Deck

proofing compound in such a manner as to thoroughly saturate, cement and bond the several parts together to form a waterproof membrane covering the whole roadway area of the bridge. This membrane shall be covered with one ply of building paper, upon which the asphalt mastic course shall then be applied to form a continuous layer over the waterproofing membrane specified above.

Special care must be taken in thoroughly bonding the edge of the waterproofing course into the vertical edge of the concrete curb.

The sidewalk slab shall be waterproofed by the use of hydrated lime mixed with granolithic concrete of the veneer surfacing of the slabs, as specified under "sidewalk surface."

The materials for concrete were brought to the bridge site in car-load lots over the Belt Line Railway and unloaded by the side of the track convenient to the mixer on the east side of the bridge and on the creek side of the railway track.

The cement was unloaded from the cars to the storage shed by a twin car gravity system.

Concrete was placed in the piers and abutments by means of a tower equipped with two hoppers at different heights, so located as to permit gravity distribution of the cement by chuting to the various parts of the work. The slope of the chutes and the consistency of the concrete was such as to prevent segregation of the component materials of the concrete.

Fig. 6 gives a good idea of the tower and chute. This view also shows the dredging outfit which was used in excavating the north pier and abutment.

Fig. No. 11.—Waterproofing the Roadway and Track Allowance

Fig. 7 shows the footing of the west wing of the north abutment in place, also the bent reinforcement rods in position in the counterparts. The chute may be noted placed ready to pour the main abutment.

Fig. 9 shows centering for the centre and north arches, also piers and north abutment stripped.

The arched slabs forming the deck of the bridge and the sidewalk brackets and slabs were placed from two buggies travelling on parallel tracks, running the length of the bridge and at an elevation of 8 feet above the roadway level. These tracks were laid on stringers supported on bents resting at first on the arch centering and as the work progressed, on the completed portions of the superstructure.

The buggies were filled by the tower chutes and provided a very flexible method of placing the concrete exactly where it was required with the minimum amount of handling and segregation of materials. The adjustable gates provided in the buggies enabled the operator to control the flow of concrete with great precision.

The above-mentioned superstructure was placed in seven longitudinal sections each of which was placed complete in one day's operation. The sections were placed alternately and by this means considerable formwork was avoided. This is clearly shown in Fig. 8, looking north from the cemetery, which shows forms in place for alternate sections. In the foreground of the picture may be observed sections of the pre-cast top rail for the balustrade.

The aviator's view, taken from the tower (Fig. 10), shows the top of the arch forms for the south and middle arches, the sidewalk bracket forms, the steel reinforcement in place, two longitudinal sections of the floor cast and the tracks for the concrete buggies.

Fig. 11 shows the street railway tracks in place and the waterproofing being applied on the track allowance and on a portion of the roadway. The north end of the east balustrade and the pre-cast lamp-posts may also be observed in this illustration. The bottom sections of the balustrade were cast in place, the panels and the small intermediate vertical sections and the top rails were pre-cast and then set in place and cemented. Finally, the main posts were cast in place.

Fig. 5 shows the site of the bridge at the commencement of operation, looking north from the cemetery.

Fig. 1 is a view of the completed structure.

The structure was designed and the construction superintended by the Toronto Department of Works, R. C. Harris, commissioner, and G. A. McCarthy, engineer of railways and bridges. C. J. Townsend, of Toronto, carried out the contract for the construction.

CANADIAN SOCIETY OF CIVIL ENGINEERS ELECTIONS AND TRANSFERS

At a meeting of the council of the Canadian Society of Civil Engineers held December 28th, the following elections and transfers were announced:—

Bonnycastle, William Robinson, of Vancouver, B.C., elected member. Mr. Bonnycastle was born at Louisville, Ky., U.S.A., 1874; educated at Washington and Lee University, 1891-93, taking an electrical engineering course at Massachusetts Institute of Technology from 1893-97. He was engineer with R. S. Masson, Los Angeles, in charge of design and water power construction developments in Azusa, Mentone and Kern River from 1902-05, and was in complete charge of the Kern River development of 15,000 horse-power, and 125 miles at 67,500 volts. In 1907 he was electrical engineer with Stave Lake Power Co., and two years hydraulic and electrical designing engineer with Western Canada Power Co. (Stave Lake Power Co.); 1912, engineer for Smith, Kerry & Chace until Mr. Smith's death; since then to present time, in private practice as consulting hydro-electrical engineer, specialty, water power development; engineer for the Bridge River Power Co., and Indian River Power Co., of British Columbia.

Bourgoing, Silvio, of Montreal, Que., transferred from student to associate member. Mr. Bourgoing was born at Tadoussac, Que., December 25th, 1884, and is a B.Sc. of Queen's University, class of 1909. He is at present assistant engineer to the city of Montreal, supervising construction of sewers for western division under S. Howard.

Buck, Cameron Alexis, of Toronto, Ont., transferred from student to junior member. Mr. Buck was born at Fonthill, Ont., April 28th, 1892, and is a B.Sc. of Alberta University, class of 1916. He is at present Brinell testing

engineer for Imperial ministry of munitions in Toronto district.

Connell, Thomas Clark, of La Loutre Dam Post Office, Quebec, elected associate member. Mr. Connell was born at Dunoon, Scotland, 25th September, 1886. For two years he was chief assistant to burgh engineer and one year as deputy engineer of Dunoon, having full charge of preparations of plans, specifications, surveys, and supervision of construction of large retaining sea wall, harbors, etc. For six months he was on the reconstruction of the C.N.R. span to Cap Rouge; two years with the St. Maurice Construction Co. at La Loutre Dam; one year as instrumentman and one year as chief assistant to Mr. Luscombe, engineer in chief, which post he still holds.

Devereux, Lawrence James, of Prince George, B.C., elected junior member. Mr. Devereux was born at St. Peter's, Cape Breton. He is at present assistant engineer on maintenance and in responsible charge of bridges and construction of depots, etc., and appropriations; also engineer representing the Grand Trunk Pacific Railway Company in connection with proposed railway changes which is handled by engineers of the Dominion government.

Douglas, Frederick William, of New York, transferred from student to associate member. Mr. Douglas was born at Toronto, Ont., April 27th, 1887, and is a B.A.Sc. of the University of Toronto, class of 1914. He is at present with the Foundation Co. of New York, as resident engineer on various contracts.

Dupuis, Joseph Herve, of Montreal, Que., transferred from student to junior member. Mr. Dupuis was born at St. Jacques L'Achigan, January 10th, 1889. He is at present civil engineer for Malcolm D. Barclay (A.M.Can. Soc.C.E.), Montreal.

Ford, Walter Stimson, of Stave Falls, B.C., transferred from junior member to associate member. Mr. Ford was born at Vancouver, B.C., December 6th, 1887, and is a B.Sc. (M.E.) of McGill University, class of 1909. He enlisted in January, 1915, and until November, 1916 was with the Canadian Railway Construction Corps, attached to Belgian engineers in Belgium and France. He is at present with the Royal Garrison Artillery,—2nd Lieutenant, 122nd Siege Battery, B.E.F.

Galbraith, John Stupart, transferred from student to associate member. Mr. Galbraith was born at Toronto, Ont., August 20th, 1891, and is a B.A.Sc. of the University of Toronto, class of 1913 (honors in all four years). From 1913-15 he was demonstrator in the fourth year Faculty of Applied Science and Engineering, University of Toronto. In 1915 he enlisted with the Royal Grenadiers, and in 1916 was on the staff of camp engineer, Valcartier. For the past year he has been with the 123rd Canadian Pioneer Battalion, Royal Grenadiers, France.

Henderson, Charles Elliott, of St. Augustine, Fla., transferred from associate member to member. Mr Henderson was born at Elmira, Ill., January 16th, 1879. He is a graduate of the University of Illinois, class of 1906, and from 1909-10 was instructor in civil engineering at the same university. He is at present county engineer, St. Johns County, Fla., in charge of design and construction of reinforced concrete bridge 2,400 feet long, and 55 miles of paving.

Howrigan, Clyde Paige, of East Fairfield, Vt., U.S.A., elected associate member. Mr. Howrigan was born at Bakersfield, Vt., August 13th, 1879. He is at present in the employ of Fraser, Brace & Co., in charge of railway construction and assistant superintendent on the Loutre Dam, Champlain County, Que.

Johnson, Ernest Nicholas, of Regina, Sask. Mr. Johnson was born at Newport, Monmouth, Eng., April 12th, 1879. In 1916 he was lieutenant with the Canadian Engineers and Royal Engineers in France, and since last April has been resident engineer on construction for the C.P.R. at East End, Sask.

MacGillivray, John Alexander, of Point du Bois, Lac Bonnet, Man., elected junior member. Mr. MacGillivray was born at New Glasgow, N.S., January 7th, 1889. He took a two-year engineering course at Dalhousie College. At the present time he is resident engineer on the 1917 extension of the city of Winnipeg hydro-electric plant at Point du Bois, with W. M. Scott.

Main, Thomas Clouston, of Winnipeg, Man., elected associate member. Mr. Main was born at Northumberland, Eng., April 13th, 1887. In January, 1915, he joined the Canadian Engineers and was sent back from France to England to take position in Royal Engineers in August, 1916. At the present time he is in charge of construction and maintenance of Seres Road in Salonika, Macedonia, with 139th Army Troop Company, Royal Engineers.

Main, Daniel Todd, of Winnipeg, Man., elected member. Mr. Main was born at Kirkintilloch, Scotland, June 18th, 1882, and educated at King William's College (Isle of Man), and Glasgow Technical College (applied mechanics. He was master mechanic for Moose Jaw, 1912-13; master mechanic for Vancouver, 1913-15; superintendent of motive power, Montreal, 1915-16. Since 1916 he has been works manager at Winnipeg.

Mitchell, Archibald Francis, of Victoria, B.C., elected associate member. Mr. Mitchell was born at Clitheroe, Eng., November 5th, 1882. He is at present acting district engineer for Major-General G. B. Hughes, D.S.O., C.B., in charge of harbor improvements, Victoria and Nanaimo; construction and maintenance of Dominion government wharves, Esquimalt graving docks. Quarantine station, wharves, roads and pipe line and other works of the department in Vancouver, which position he has held since 1914.

Mitchell, Coulson Norman, transferred from student to associate member. Mr. Mitchell was born at Winnipeg, Man., December 11th, 1889. He is at present lieutenant with the Canadian Engineers, No. 1 Tunnelling Co., B.E.F., France.

Moore, Ulric Robert, of Ottawa, Ont., elected junior member. Mr. Moore was born at Toronto September 27th, 1891. He is at present adjuster, Imperial Munitions Board.

Noonan, William F., of Kingston, Ont., transferred from student to junior member. Mr. Noonan was born at Kingston, Ont., August 31st, 1890, and is a B.Sc. of Queen's University, Kingston, Ont., class of 1914. He is at present civil draughtsman, C.R.C.E. Office, Military District No. 3, Kingston, Ont.

Tilt, Edwin Bingham, of Madrid, Spain, elected associate member. Mr. Tilt was born at Waterloo, Ont., 6th March, 1879, and is a B.Sc. of McGill University, class of 1903. From 1915-16 he was chief inspector of steel, Imperial Munitions Board, and at the present time is president and general manager of the Sociedad Hispano Americano, Gaston Williams, of Wigmore, C.A., Madrid, Spain.

Wing, Daniel Oscar, of Toronto, Ont., elected associate member. Mr. Wing was born at Camden, Ont., April 6th, 1886, and is a graduate of the University of Toronto, class of 1908. He is at present a land surveyor for British Columbia.

OXY-ACETYLENE AND ELECTRIC WELDING AND CUTTING PROCESSES IN LOCOMOTIVE SHOPS*

By A. F. Dyer
General Foreman, Welding Department, G.T.R., Montreal.

With the present prices of material, scarcity of labor, and difficulty of obtaining steel and iron, welding and cutting by both the above-mentioned processes have proved a great boon and an almost indispensable factor in railway repair shops. Seven years ago we employed one man as an acetylene welder, and owing to failures, through his lack of experience, the process was nearly condemned, but as we gathered experience, both gas and electric welding developed, so that now instead of one man we employ 18 and have often to work them overtime.

The low-pressure acetylene gas system is used, and the whole shops are piped for the acetylene, every other repair pit has a drop connection, in locomotive houses we use Prest-O-Lite dissolved acetylene in cylinders, which saves the expenses of a generator and piping where the process is only in use occasionally. There is a great difference in opinion as to the relative merits of high or positive pressure and low-pressure gas, the manufacturers of pressure outfits contending that you save oxygen by using their type of generators and that you cannot get so near to a neutral flame with the low-pressure gas as you can with the high. The makers of the low-pressure outfits claim that by the use of an injector embodied in the torch or welding head, a neutral flame can easily be obtained. We find we can obtain a flame as nearly neutral as can be obtained, with the outfit we use, although with pressure gas you can obtain a much larger flame for the same sized head than with the low pressure. The principal factor, however, that made us decide on the low-pressure outfit was the fact that our main supply pipes are carried overhead throughout the shops, and as nearly all, if not all, oil, steam and water pipes are overhead, we had to consider a very well known motto, *viz.*, safety first, for if a man was working overhead and by mistake broke a joint of the gas pipe, his torch or candle might cause an explosion which might wreck the shop. Though we have been using acetylene gas for eight years, we have never had an explosion of any sort. Our low-pressure generator went through a big fire two years ago, and we were enabled to repair it and use it for several weeks, till we received our new outfit.

There are many kinds of electric welding outfits on the market, and, of course, each one is claimed to be the best by its respective makers; each has its advantages and, whisper it, its disadvantages, and the old prejudice very often exists among operators that the machine they are using and are familiar with is the best, and they will stick to that opinion until they become accustomed to a new machine. A new equipment, using alternating current instead of the direct current, is now being put on the market, and only weighs 150 lbs., and gives from 20 to 200 amperes, and is about 50 per cent. cheaper than any d.c. machine on the market. The electric welding outfit consists of two generators, each operating four welding circuits; the shops are wired and at convenient places connection boxes are placed, and only need a lead and ground wire connected to them and the work on which the welder is engaged. The outfit used has panel controls, which allow each man to control his amperes independent of the other welders.

The processes have proved themselves fit to be ranked amongst the greatest time and labor savers, and also we may safely say money savers, introduced for a long period. For instance, in the not very distant past, a locomotive with a broken frame had to stay several days in the shops before the men could strip down one side and remove the frame to the smith's shop, weld it and perhaps have it machined and then replaced. Now we drop the pair of wheels which may cover the break, cut out the crack with the cutting torch, to the shape of a double V, at an angle of 90°, clean off the oxide caused by cutting, and weld up with the metal electrode, using soft steel for Swedish iron, a frame 4 x 5 ins. being cut and welded in under 14 hours, and it can be done in less time by having two operators on the frame at once, but the men do not like facing each other's arcs, as when they are changing their filling rods their eyes get sore.

Frames, when worn by brake gear and stays, are built up, and worn holes are plugged and welded, instead of reaming them out to a larger size and thereby weakening the frame. In rebuilding and superheating engines, the same boilers are seldom used on their original frames, and as in very few cases do the various holes in angle irons, furnace bearers, etc., come into alignment with frames or boilers, the holes are welded up and re-drilled.

The present price of tool steel demands that none shall be wasted, therefore we use it down to the last inch, by welding it to tire steel. Twist drills, taps, and reamers, when broken near the socket end, are welded and put into use again. For this purpose we use either the electrode or gas, but in both cases we use vanadium steel filling rods, as we find this gives the best results. Spokes of driving wheels are welded, and flat spots on tires have been successfully welded up when it was necessary to do so.

We have not had much success on cast iron, with the iron electrode, although with the carbon you can make a fair job, but the gas is unquestionably the best for any of this material. We have successfully welded with the gas, steam shovel engine frames, slides and cylinders, by welding in patches of cast iron where worn or broken. When our contract for shells was completed and the lathes that were used for this purpose were being overhauled, it was found that most of the V slide beds were worn down by the tool carriers; these were built up with the gas, which saved machining these beds down in many cases 3/8 in.

Most of the boiler welding is done with the iron electrode, using a mild steel or Swedish iron as a filler. It is found that the electric process localizes the heat more than the gas does though it is the writer's opinion that gas makes a closer and neater weld, as all welds made by the electrode are more or less porous, unless hammered up. It pays better, whenever possible to do so, to put quarter or half sides, in order to get out of the fire line, in preference to putting in a patch, for, as a rule, however well the patch is welded it generally gives out in from 12 to 18 months' service, and the same applies to cracks, whereas the half or quarter side should last as long as the firebox.

When a nest of small cracks is found round the staybolts, the bolts are removed and the holes countersunk and welded up. This method has been found to be very successful. Corner patches are welded in by running the patch into the tube or back sheets, as the case may be, at the same time removing the flanges. If it is decided to do away with a number of tubes, plugs are welded in the holes, first countersinking the holes and having the plugs

(Concluded on page 42)

*Abstracted from paper read before the Canadian Railway Club in Montreal.

THE FLOW OF WATER IN SIPHONS*

By Mark Halliday

An analysis of the flow of water in siphons, simple and compound, suggested itself to the writer after the perusal of the discussion of Mr. George R. Nicholson's paper on "The Horsley and Nicholson Automatic Compound Siphon."

Consider first the simple siphon shown diagrammatically in Fig. 1, which is arranged to siphon water from the tank A over the point B to the tank C.

Let H_1 = static head in tank A above datum;
H_2 = static head at point B above datum;
H_3 = static head in tank C above datum;
p_1 = pressure in pipe at entrance A;
p_2 = pressure in pipe at point B;
p_3 = pressure in pipe at exit C;
v_1 = velocity of water at entrance to pipe at A;
v_2 = velocity of water in pipe at point B;
v_3 = velocity of water in pipe at exit C.

Then, by Bernouilli's theorem—

$$\left.\begin{aligned} &H_1 + \frac{p_1}{62\cdot4} + \frac{v_1^2}{2g} \\ &= H_2 + \frac{p_2}{62\cdot4} + \frac{v_2^2}{2g} + \text{friction head from A to B} \\ &= H_3 + \frac{p_3}{62\cdot4} + \frac{v_3^2}{2g} + \text{friction head from A to C} \end{aligned}\right\} \quad (1)$$

The friction head in feet $\frac{4\,f\,l\,v^2}{2\,g\,d}$ for round pipes - (2)

where f = coefficient of friction; l = length of pipe, in feet; v = velocity of water, in feet per second, and d = diameter of pipe, in feet.

Transposing equation (1) gives—

$$H_2 - H_1 = \frac{p_1}{62\cdot4} + \frac{v_1^2}{2g} - \frac{p_2}{62\cdot4} - \frac{v_2^2}{2g} - \frac{4\,f\,l_1\,v_2^2}{2\,g\,d} \quad (3)$$

l_1 being the length of pipe from A to B, the loss at entry to the pipe is neglected.

Also, if the pipes are of equal diameter throughout, $v_1 = v_2$.

In order to obtain the maximum velocity at point B, $p_2 = 0$.

Then $$H_2 - H_1 = \frac{p_1}{62\cdot4} - \frac{4\,f\,l_1\,v_2^2}{2\,g\,d} \quad - - - - \quad (4)$$

but $\frac{p_1}{62\cdot4}$ = head of water, in feet, equivalent to atmospheric pressure or, say, 34 ft.

Then $$H_2 - H_1 = 34 - \frac{4\,f\,l_1\,v_2^2}{2\,g\,d} \quad - - - \quad (5)$$

Let $$H_2 - H_1 = h_2 \quad - - - - - - - \quad (6)$$

Then $$v_2 = \sqrt{\frac{2\,g\,d\,(34 - h_2)}{4\,f\,l_1}} \quad - - - - \quad (7)$$

Also let $$H_1 - H_3 = h_3 \quad - - - - - - \quad (8)$$

$$\frac{p_1}{62\cdot4} = \frac{p_3}{62\cdot4} = 34 \text{ ft.} \quad - - - - - - - \quad (9)$$

And $v_1 = v_3$ if the pipes are of equal diameter.

From equation (1)—

$$H_1 = H_3 + \frac{4\,f\,l_2\,v_3^2}{2\,g\,d} \quad - - - - - - - \quad (10)$$

l_2 being the length of pipe from A to C.

*From a paper read before the North of England Institute of Mining Engineers.

$$\therefore\ v_3 = \sqrt{\frac{2\,g\,d\,h_3}{4\,f\,l_2}} \quad - - - - - - - - - \quad (11)$$

$$v_3 = v_2 \quad - - - - - - - - - - - - - \quad (12)$$

Then $$\frac{2\,g\,d\,h_3}{4\,f\,l_2} = \frac{2\,g\,d\,(34 - h_2)}{4\,f\,l_1} \quad - - - - - - \quad (13)$$

or $$\frac{h_3}{l_3} = \frac{34 - h_2}{l_1} \quad - - - - - - - - - - - \quad (14)$$

Unless this relationship holds, the siphon will not work continuously without a regulating valve. It will be noted that h_2 equally as much as h_3 governs the discharge. If h_3 is excessive, then v_3 tends to become larger than v_2, and cavitation in the pipes will result.

This explains the statement made by so many that some siphons work better when the valve at the delivery end is partly closed. This must necessarily be the case, as the valve must be regulated until (v_3 × area at C) = (h_2 × area at B).

The same reasoning when applied to the Nicholson compound siphon results in the following deductions:

Fig. 2 shows the diagrammatic arrangement of the siphon; H_2, $\frac{p_3}{62\cdot4}$, and v_3 are the static pressure, velocity and energies per pound of water respectively at the air inlet N of the compound siphon. Then if the air inlet and trap N, S, N, is fixed in a position according to the relationship in equation (14), *viz.*, such that $\frac{h_3}{l_2} = \frac{34 - h^2}{l_1}$ (14), the compound siphon will discharge as much water as any simple siphon.

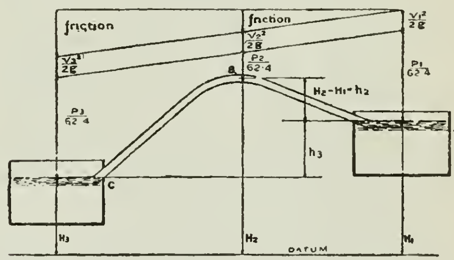


Fig. 1.—Single Siphon Shown Diagrammatically

It has been assumed throughout that f, the coefficient of friction, is the same for the whole length of pipe considered; also, in order to simplify the argument, that $p_2 = 0$.

For a maximum discharge, this would be so, but the analysis would hold equally well if p_2 had a value of a few feet.

In that case the figure could be inserted to slightly modify the result in equation (14).

Discussion.

Mr. G. R. Nicholson, whose paper had inspired Mr. Halliday's analysis, remarked that he wished Mr. Halliday had enlarged on the question of cavitation. Whenever a simple siphon was worked on a long length of pipe line, considerable friction occurred, and when an extensive length of pipe dropped a considerable depth below the level of the water at the intake, by the law of gravitation the velocity at the outlet would be greater than the velocity at the intake and cavitation occurred at the highest point of the siphon, i.e., a partial vacuum

was formed by the increased speed of the falling or pulling leg being greater than the speed on the intake side. After a time, cavitation extended to a point at which the column of water in the siphon was broken in two parts, one column dropping down each leg of the siphon, which became empty. Many siphons worked better with a cock at the outlet. This required careful adjustment and close attention to get the best results. In the Nicholson automatic compound siphon, cavitation was impossible, and a regulating cock was not required. It was self-contained and self-adjusting in every circumstance that might arise. It had no mechanical action, being entirely atmospherically controlled.

Mr. Halliday stated that the whole analysis pointed to the fact that, unless the relationship in equation (14) held good, they must have a throttle outlet. If that were provided, and the velocity at the outlet equalled the velocity at the top of the pipe, cavitation would not take place. No doubt there were in that neighborhood hundreds of siphons working under these conditions without ever breaking down. He had occasion to put in a siphon recently delivering quite 3,000 gals. per minute. It was a simple siphon, with a lift of a few feet. It had been working nine or ten months now, and had never stopped once. He held that cavitation could occur with the Nicholson siphon.

Mr. Nicholson: Not to the extent of breaking up.

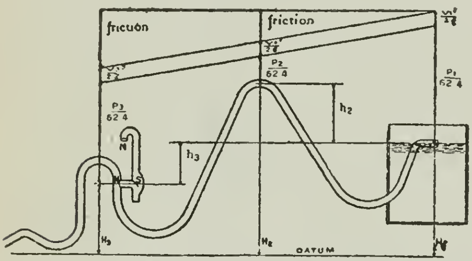


Fig. 2.—Amended Diagrammatic Arrangement of Siphon

Mr. Halliday added that, if the air-trap were fixed in a certain position given by equation (14), the Nicholson siphon would deliver as much water as any other siphon. In the previous discussion on Mr. Nicholson's paper, that had been disputed, but it was so.

Mr. Nicholson said that a short time ago he had an enquiry from a Lancashire colliery where there was a siphon working. To make sure that it was perfectly tight, they had taken the pipes off and re-laid them three times. They put a valve on the outlet and said that, when it was left at full bore—it had an excessively long leg—it simply broke up after three or four hours' working. After he put a cock on and readjusted it, however, it sometimes worked for several days.

Mr. Mark Ford remarked that there was a good deal of bother with siphons in mines. He asked whether that was because mine water contained air and gas, and that the reduced pressure at the top of the siphon caused the air and gas to cling to the top of the pipe.

Mr. Halliday replied that that might be the cause if air accumulated at the top of the siphon. When once that pressure reached a certain figure, the siphon would stop work. He assented to Mr. Ford's suggestion that the pressure of water would be reduced at that point, and that the tendency would be for the water to give up its air or gas at that point.

The president said he had seen gas gathering at the head of a siphon so that, if one opened the plug, one could have lit it. They had a lot of trouble many years ago with water containing so much gas. He dared say that that could be got rid of by regulating the outlet, so as to keep the gas out in a great measure.

Mr. Ford questioned whether there was anything to prevent the accumulation of gas at the top.

Mr. Halliday agreed that, if they had considerable quantities of gas in solution in the water, when they commenced siphoning, the gas was naturally given off at the highest point of the siphon. He asked Mr. Nicholson how he dealt with that problem.

Mr. Nicholson replied that there was a T-piece at the inlet end of his siphon, which stopped atmospheric air from getting into it. He quite admitted that gas in solution might be in the water, however. As the water passed through, this gas formed a small air lock in the first instance, and that air lock was carried through like a solid cartridge. The gas came off in small globules right through the pipe, but, if there was any flow of water at all, these globules did not adhere to the side, but were carried through. If the siphon were standinng, these globules adhered and, after a time, rose to the top. The siphon would have to stand a very considerable time, however, before there was enough gas generated from the water to break up the siphon. In practice, he thought that the amount of gas generated in the pipe was very, very small.

Mr. Halliday remarked that it might amount to 3 or 5 per cent.

BUILDING SHIPS IN RECORD TIME

The Foundation Company, on December 27th, launched the first of the ships outlined on the Imperial Munitions Board Emergency shipbuilding programme.

Last spring the Imperial Munitions Board placed several orders for wooden ships, and these are being constructed in different parts of Canada. The ships are rated at approximately 2,500 tons, and have a length of 250 ft. and a beam of 43 ft. 6 in. The elapsed time from the breaking of the ground to the launching of this ship was approximately six months, which bears testimony to the ability of Canadian organizations to rise to the assistance of their country in these times of emergency.

The Foundation Company's shipyard is in charge of W. I. Bishop, who is well known in the contracting and engineering field in Montreal and Toronto.

MOUNTAIN FOR WATER-FRONT FILL

The engineer who is undertaking the cutting down of the Costello Hill at Rio de Janeiro, Brazil, and using the material to reclaim a large area of submerged land on the water-front is Luiz Barretto Filho, of Sao Paulo, Brazil. The present property on the hill would have to be purchased, but the levelled site and the newly-filled site would become the property of the syndicate for development purposes. The cost of removing the 4,700,000 cu. yds. and depositing them in the fill is estimated at $10,000,000. The removal of this hill has been proposed at various times for more than 100 years, the object being to improve the ventilation of the city, as cool winds are now obstructed.

RELATIVE EFFICIENCY IN METHODS OF REPAIRS TO BITUMINOUS MACADAM AND BITUMINOUS CONCRETE PAVEMENTS*

By George H. Biles,
Second Deputy State Highway Commissioner of Pennsylvania.

In recent years there has been marked development in the methods of repairing and rehabilitating bituminous pavements. There are innumerable instances where pavements had apparently arrived at a stage of such failure that their entire reconstruction seemed justifiable, but by scientific, efficient and economic methods of the highway engineer they have been repaired at a great saving in cost, which in the end is one of the most essential factors in all construction work.

Bituminous macadam is represented principally by the penetration method types of pavement. Naturally, in the analysis of this subject, the first thought is directed to the causes of the various forms of disintegration or failure in pavements of this type, and whereas it is extremely difficult in all cases to arrive at definite conclusions, observation, experiment and laboratory analyses of samples taken from the pavements furnish invaluable data from which fair judgment can be made. Before taking up the efficiency of the actual methods of repair, some of the failures and causes of disintegration common to these types of pavement will be described briefly.

The bituminous penetration method road in its various stages of disrepair or disintegration furnishes a fertile field of opportunity for study and experiment. The most common deficiency in this type of work is found in the non-uniformity of the surface. As an example, we have, first, a section of road where the surface is composed of spots of excess bituminous material, and bare or lean areas, where the binder is lacking in quantity, which condition results in a short time in a ravelling or breaking up of the road surface. This condition is usually caused by improper distribution or by incorporating the bituminous material when the stone is not thoroughly dry.

Second.—A rough surface is presented where the stone is loosened or ravelled, the binder showing rapid deterioration, generally causing a series of pot-holes. This may be occasioned by improper or overheated bituminous material, unsatisfactory aggregate or faulty subdrainage.

Third.—At times we have apparently a lifeless surface in so far as the bitumen is concerned, but upon further examination it is found to contain bituminous binder with considerable life a slight depth below the surface. This condition is due in many cases to an insufficiency of bituminous material.

Fourth.—A pavement may present a wavy and uneven appearance, and this is usually due to an excess of bituminous material, or is caused by the bituminous material being too soft to withstand the action of traffic.

Fifth.—There are surfaces which consist of ridges of material which are the result of irregular or improper pouring—in most cases, careless hand-pouring. A surface of this kind suffers quickly from the impact of traffic and the attack of the elements, and early disintegration is the result.

Sixth.—We have a fairly well-shaped, uniform surface becoming porous. This condition is true of all bituminous highways in time, as it represents the beginning of the deterioration of the bituminous material.

It will be seen that before repairs are taken up on bituminous macadam roads, careful study and examination are necessary in order to select the most effective method. Taking the several conditions in order as hereinbefore mentioned, the first case, if taken in time, can be repaired by sealing the dry or lean spots in the surface with a light, heated application of bituminous cement of the binder grade, or the cold bituminous surface treatment materials in quantities ranging from one-tenth of a gallon to three-tenths of a gallon to the square yard of surface, covered with chips or pea gravel, using between fifteen and twenty pounds to the square yard. Unless the surface is badly worn, repairs of this character will even up the surface to a true cross-section, giving added life to the pavement.

The second condition calls for heroic treatment if of any great extent, and a complete scarifying and harrowing of the surface becomes necessary. All disintegrated material must be removed and sufficient new stone added to give the required depth before the surface can be repenetrated and sealed as in the original construction. If, however, the affected portions are only occasional and do not represent the greater area, they may be cut out, cleaned thoroughly and filled with new stone, making due allowance for compression, then penetrated, etc., in the manner hereinbefore mentioned. If drainage conditions are responsible for the failure, they must be corrected before any surface repairs are taken up.

The condition described in the third example may be treated in two ways. The most economical, so far as first cost is concerned, would be to give the pavement a treatment, in sufficient quantity to fill the surface voids, with a material that will penetrate and enliven the old material, followed by a covering of good, hard stone chips, using about twenty pounds to the square yard. The alternative would be to scarify and harrow the whole surface, supplying additional new stone in quantities as the rolling would indicate to be required to give the proper cross-section, and penetrating the surface with a bituminous binder, sealing again as in the original construction. In the latter method the surface must first be thoroughly cleaned, and in scarifying and harrowing the remaining bituminous material in the road must be distributed as evenly as possible. If the material found in the pavement, however, does not possess life, this method is a hazard.

In the wavy, corrugated surface, where there is found to be an excess of bituminous material, it is generally more economical and satisfactory to scarify and reshape the surface, adding new stone in order to take up the excess bitumen, and again sealing the surface. This same method should be followed where waves have been caused by the bituminous material being too soft, only, perhaps, more stone would be required in the reconstruction, and it would be essential to incorporate a harder bituminous binder than was used in the original construction.

Occasional waves in the surface may be taken out in the due course of ordinary repairs by cutting off the high places and resealing if the conditions are very pronounced, or by cutting out the depressions and replacing with new material.

A surface full of ridges, due to improper pouring, if not too pronounced, may be evened up by painting between the ridges with bituminous cement and covering with stone chips or gravel. This method may be continued from time to time until the surface is entirely evened up. This condition may also be corrected by scarifying the

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surface with the object of obtaining a more uniform distribution of the old bituminous material, and, after rolling to the proper shape, by applying a surface treatment of a cold bituminous material that will enliven the existing material and seal the surface. This treatment is covered with stone chips in the manner prescribed for regular bituminous surface treatment work.

In the last case we have a properly constructed bituminous penetration pavement, but the bituminous material is starting to deteriorate. This can be enlivened or revived by cleaning the surface and applying a seal coat of material in quantities, depending upon the degree of disintegration. Caution should be exercised to avoid applying an excess amount, which results in a slippery condition, and is very objectionable to horse-drawn traffic. Generally, one-tenth to one-sixth of a gallon is used and brushed into the surface with hand-brooms. The surface is then covered with chips or gravel approximating twenty pounds to the square yard. In the use of certain slow-drying, cold bituminous materials it will be observed that this new material softens up the old bitumen somewhat, giving the appearance at first of an excess application, and, having a hard surface underneath, the road becomes quite slippery, but this condition obtains for only a short period of time.

To insure the best results, one-half of the road should be treated at a time in order that the traffic may use the other portion while the bituminous material is setting up. This method has become quite effective, and results in increased life to the pavement.

In the repairs of breaks, depressions and local defects, which may occur under any one of the general conditions previously outlined, it is more satisfactory to use hot bituminous binders, and if replacements are necessary, they can be made after the fashion of the original construction. This work can be done very efficiently in this manner with little equipment and the average class of labor. There are a number of instances where cold bituminous compounds can and are being used successfully in certain seasons of the year on pavements of this kind, but in cold weather there is usually difficulty with some of this material, owing to its composition. As an example, the emulsified products break down or separate, and their adhesiveness is destroyed at low temperatures. Materials that are cut back with natural solvents can be used later and give very good results. The mixtures can be prepared at some point, not exposed to the weather, but convenient to the work, hauled to the site of the repairs and deposited. This is an effective method in case of emergency.

Bituminous Concrete Pavements

The various mixed bituminous pavements, with the exception of sheet asphalt, are included in the class of bituminous concretes.

Careful observation in locations where there is considerable bituminous paving shows that different streets, in spite of the fact that they have been constructed of the same material, present different appearances. Cracking of the surface is one of the greatest, as well as one of the earliest, defects that may develop in bituminous pavements. This may be due to one cause or a combination of several causes. Frequent cases are noted in bituminous wearing surfaces, which, although apparently satisfactory mixtures in all other respects, contract as the base contracts, and crack open at exactly the same point as the foundation. Again, cases are noticed of otherwise satisfactory pavements which crack because of their failure to receive the amount of traffic necessary to give the pavement its full compression, or to iron out and close up the surface after low temperatures have tended to open it up by stretching the bituminous binder.

A condition of the sort last described, however, may have been hastened considerably, or even caused directly, by what might be called improper design of the pavement in the first place.

The bituminous surface mixtures expected to receive heavy traffic should be tough and fairly hard in order to resist displacement. Those designed for light traffic should be softer and more yielding, and this is accomplished by using a softer bitumen, that is, one of a higher penetration. Failure to do so means that as the pieces of mineral aggregate contract or shrink in volume during cold weather, they exert a spreading force in the surrounding bitumen, which it cannot withstand because of its lack of light fluxing oils and corresponding ductility or ability to stretch; in other words, pavements containing hard or non-ductile bituminous material will have a greater tendency to crack in cold weather. Similar results, and even general disintegration of the wearing surface, may have been produced by too little bitumen in the mixture, since this is largely a measure of the life and elasticity of the pavement; and, similarly, overheated mixtures suffer a hardening and reduction of bonding power of the bitumen, with consequent tendency to crack and wear. Aside from faulty drainage, poorly proportioned mixtures and unsuitable ingredients contribute largely to the failures in this type of pavement.

A bituminous concrete pavement which is satisfactory in all other respects may show surface indications of slight disintegration. The material in all probability has been attacked by the elements and evidence of wear is shown as the gloss is gone and the discoloration of the surface, which approaches a light brownish hue, is noticeable. This is speedily followed by a general porous condition and, if not promptly attended to, will allow the surface to retain moisture, which will eventually break the bond of the material and result in ravelling and failure of the pavement.

The wavy condition of the surface found in the bituminous macadam roads is also common to the bituminous concrete types. This condition is usually found on well-travelled streets, especially on grades, and is caused mostly by the bituminous mixture being too soft, which gives it a tendency to push under traffic. A wavy surface may be attributable to the methods used in the construction of the pavement for, if in the building the material was not at a temperature suitable for raking to a uniformly loose condition, or crept under the roller as a result of careless handling or being rolled while too hot, an irregular surface would result. Pushing or waving in local spots may often be traced to the laying of the mixture on a dusty or dirty surface.

The wearing and deterioration along the edges of bituminous pavements where there is no header, is responsible for one of the most troublesome and expensive forms of repairs to roads of this type. The traffic continually irons out the surface along the edges and this spreading or flattening out produces a feather edge along the sides. The moisture and foreign material tracked on from the shoulders soon attack the bituminous material and result in the crumbling or breaking away of the surface which occasions extensive repairs. This condition is more pronounced when the material in the shoulders is of a nonporous nature or is poorly drained.

In the repairs to the bituminous concrete pavements, special care is required in determining the methods and materials to be used. Taking the several conditions

enumerated in the foregoing in their order, we first have a cracked bituminous surface and, unless the cracks are caused by some serious form of disintegration in the pavement, they can be repaired by cleaning them out thoroughly and pouring them full of either a hot or cold bituminous material of the proper grade, and thereafter tamping or wedging stone chips into the crack, thoroughly sealing it. If the crack is wide enough and the edges have crumbled or broken off, they should be cut down evenly and the opening filled and tamped with a mixture of the bituminous cement and stone chips in a proportion of one part bituminous cement to nine parts chips, in sufficient quantity to insure complete closure.

When the entire surface is cracked or broken and is uniformly bad and gradually crumbling away due to the disintegration of the material from any of the several causes hereinbefore mentioned, it becomes necessary to remove the old material and replace with a new surface. If the condition exists only in local spots this will develop into pot holes or depressions which can be repaired by cutting out the affected areas down to the foundation and replacing with a new mixture.

The character of the bituminous material to use depends entirely upon the conditions in each case. Unless the repair work is extensive, it is not deemed advisable to use hot bituminous compounds in this work, not only from an economic standpoint but from a point of convenience as well. Small repairs in the proper season can be handled economically and efficiently with cold bituminous cement and if the proper mixture is used in the regular working season excellent results can be obtained.

It is conceded that hot bituminous repairs are not generally satisfactory when made at low temperatures, but in some places the avoidance of this practice has been carried almost to a fault. As an example, in some of the larger municipalities where defects have developed in the surface during the winter months, the affected portions have been removed and repaired with brick or stone block. This method is not only objectionable on account of the annoyance to traffic but when the regular season for repairs arrives it is usually found that additional work is required, occasioned through the inequality of the surface. It has been stated by some of the advocates of this method that it is an assurance that the affected portions will not be overlooked when the repair work is taken up in the spring. It has been demonstrated, however, that where conditions are so acute that this method is warranted, there is justification for making special arrangements for preparing and placing a suitable bituminous mixture which will be more satisfactory in the interim and, whereas, probably not a complete success, will offer as good, if not better, opportunities to correct later than the first method, which seems only to be justified when repairing cuts made in the pavements by public service corporations in the winter season.

When the surface of a bituminous concrete pavement begins to show that the bituminous material is disintegrating and the surface has a dry, porous appearance, similar to the appearance of the bituminous macadam pavement previously described, the surface can be revived by a light bituminous surface application the same as in the former case.

The wavy, irregular surface on bituminous concrete pavements is one of the most unsatisfactory conditions pertaining to the bituminous type of pavement. It is a defect that in most cases is proof positive of the inability of the pavement to meet the traffic requirements, except when the fault may have resulted from the methods used in the construction rather than the materials. If the materials have been found unsatisfactory and the irregularity of the surface is increasing steadily, reconstruction will eventually be necessary.

If the surface is only affected in local spots due to any of the other causes enumerated, this area may be removed and replaced with a new mixture which has been properly selected and strict attention should be given to the requirements of the mixture in order that a repetition of the original deficiencies cannot obtain.

When the proper material has been used in the original construction and the surface is irregular through careless methods in spreading, beneficial results can be obtained from rolling the surface in hot weather with a tandem power roller operated by a competent man.

In the repairs to the edges of a bituminous pavement not confined by headers, the first and most essential thing to do is to correct the cause, if possible. If the drainage of the shoulders or base is faulty, this should be taken into consideration first and ample provision made therefor. On shoulders which are composed of non-porous material, it is advisable to cut scuppers or small surface ditches at intervals of approximately twenty feet along the road and, in addition to this, the material immediately along the edge of the pavement should be replaced for a depth of a few inches with broken stone or gravel tamped into place to produce a more stable buttress for the new bituminous material. The patches should be made by removing the affected area and replacing with new mixture. Successful repairs should neither be above nor below the surrounding surface when finally compacted.

In municipalities where there is enough yardage to warrant a central mixing plant, this is the most satisfactory method of handling bituminous repairs. With every facility at hand to compound the mixture properly, more uniformity is assured and much of the personal equation resulting from separate organizations is eliminated. There are localities where possibly small portable mixing plants would meet the requirements and give satisfactory results. However, under ordinary conditions, the problem is generally a small town with probably several short streets or some other unit, such as a county or state, with continuous stretches of miles of interurban bituminous pavements or highways. In either case, it means one or a number of outfits performing the repair work, which conditions give strength to the demand for simple and efficient methods. With trained men, good hot bituminous mixtures have been prepared by hand, but considering the chances taken in over-heating the material, the careless proportioning and mixing and the extra expense in connection with the handling of the equipment, etc., it does not justify this method. The cold bituminous mixture with the proper material is the most economical and fool-proof method for ordinary repairs. The material can be mixed on a regular mixing board, stock prepared for future use, if need be, and stored at convenient intervals along the road and, aside from the small tools, such as shovels, rakes and tampers, no other equipment is absolutely necessary. Repairs have been made with cold bituminous mixtures on extremely heavy-travelled roads that are in excellent condition after four seasons of wear.

In a recent report of the Coal Conservation Sub-Committee on the Supply or Electrical Power, proposals are made which would revolutionize the industry of Great Britain. The main reforms advocated are as follows: Construction of 16 super-power stations in different parts of the country; supervision, with adequate compensation, of 600 smaller undertakings now in existence; utilization of the by-products at each of the big stations; national control of the whole undertaking by a national board of electricity commissioners.

THE BASIS OF WATER CHARGES IN URBAN AREAS FROM THE POINT OF VIEW OF COMMON UTILITY*

By E. C. Rodda
Waterworks Engineer and Manager, Southampton.

I FEEL convinced that any discussion on water charges will be largely barren of any useful result unless there can be found some common ground of agreement with respect to the general principles upon which moneys should be raised for a great public service of common utility.

If we can show that the public water supply is not the least important of the great public services, and is not primarily of individual benefit, we are entitled to say that no class or individual of the community should be allowed to escape from a due and proper share in the cost thereof.

We are in danger, and by we I mean the people who enjoy the benefits of water supply on the one hand and ourselves who administer the supplies on the other—by a long and close familiarity of the many and great blessings accruing from a modern water supply—of losing sight of that characteristic which distinguishes it from all the other public services—*viz.*, that of its indispensability.

Our modern water supplies are essential to life itself; they are essential to the public health; they are essential to the security of property; and they are essential to the increasing comfort and well-being of the community.

You may think I am exaggerating this danger. Let us take a typical example of the consumer. Here is a man who has a combined residential and business premises. Finding that the value of water consumed per meter is less than what he is asked to pay as a minimum charge, and finding also that he has already paid for the public sanitary purposes, he desires to know what the balance is for. He is often told that if his premises are threatened with fire, the water used for extinguishing the fire will be supplied free of cost. But this answer does not satisfy him, because his property is covered by insurance, and he points out that except he goes to the expense of a sprinkler installation the premium he pays is very little less than he would pay for a house in the country miles from the nearest water main and miles from the nearest fire-brigade station.

Benefits of a Water Supply

On the face of it, then, the individual has no interest in the public water supply so far as it might protect his own property. But is this really so? Can we imagine the effect of any of our great urban areas being suddenly deprived of the water mains simultaneously with a great outbreak of fire? . . .

Without pursuing the matter any further, it is evident, I think, that no individual can deny his obligation to the public water supply, inasmuch that, despite the aids from fire insurance and the fire brigade departments, the great fundamental safeguard to property is the existence of an abundant supply of water at an adequate pressure.

Now note that in this typical case of the consumer the individual pays for police protection, for public lighting and paving, for the purposes of public health, for old age pensions, for the care of the poor, for the education of his neighbor's children, even supplying them with free meals, and so on. But in regard to the water supply he questions his obligations. Yet his obligation to the water supply as a safeguard of public property is not the only one.

Take the public health. I find it a difficult matter indeed to put in a few paragraphs what can only adequately be dealt with in a much larger space, and I am awake to the difficulties of justly attributing to the water supply its particular benefits on the public health, and of appearing to be unfair to the other important agencies—*e.g.*, the removal of refuse, sewage disposal, the better housing of the poor, education, etc.; but when all is said for these other agencies, it must still remain true that most of the labor of the Health Department would be wholly undone in the absence of a good water supply. When first introduced there was a great prejudice against drainage, many of the sewers being nothing more or less than elongated cesspools, and remained generally ineffective until water mains were laid in the streets.

The Meter System

I believe the great majority of those whose duty it is to administer our water undertakings are opposed to the idea of the universal supply of water by measure—a system which is largely in use in Germany and America—for it is recognized that in order to supply water to the poorer classes absolutely without restrictions and at the lowest possible price—invariably at a loss—the present basis of charging on the rateable value for domestic supplies is never likely to be improved upon.

But nevertheless there are a number who, while refusing to go to the extent of metering every service pipe, are obsessed with the idea that the revenue from each class of consumer—*viz.*, the domestic consumer, the occupiers of combined business and domestic dwellings, and lock-up shops, and the trade consumer—should bear an equal proportion of the cost per unit of assessable value. Now there are two main questions to answer here: (1) Who is to bear the loss on the lower rated domestic dwellings, and (2) who is to bear the loss of water by unavoidable waste?—a large item in some towns.

One of the strongest reasons for the writing of this paper is the necessity I see of attacking the tendency to regard the supply of water by measure as the only equitable, or the most equitable, means of raising revenue therefor.

This view was prominent in the Metropolis Water Bill of 1884, promoted by the Corporation of London, for regulating the water supply of London, but this bill, like the purchase bills of 1878 and 1880, was a failure. It was proposed to supply water by measure, it being urged that a charge based on the rateable value was not fair, being irrespective of the consumption. The consumer had the option, however, of taking the water by meter with a minimum charge at 6d. per 1,000 gallons, or being charged upon the rateable value.

The water companies cried out against the proposal to supply by meter as a measure of confiscation, and warned the corporation that it would result in a large public rate for sanitary purposes owing to a certain stint in use of water under a meter system. The corporation tried to meet this argument by recognizing "that sanitary requirements demanded that water should be used without stint, and that it is necessary that the wealthier consumers should, by paying an enhanced price, cheapen the cost of water to their poorer neighbors, and encourage them to use it freely." This in turn was denounced as socialistic.

*Extracts from paper read at a meeting of the Municipal Waterworks' Association held at Birmingham, England.

What the Consumer Pays

Let us see what a better-class domestic consumer pays for water. Take the rate at 1s. 6d. in the £, which is a little above the average for the whole of the boroughs and county boroughs; a dwelling rated at £100 per annum, containing seven persons, including servants, and the actual quantity of water used at 14 gallons per head per day. (I assume here that the domestic supply including waste is 20 gallons per head per day.) This consumer then pays 4s. 2½d. per 1,000 gallons, and a consumer occupying a house rated at £200 per annum would pay, other things being equal, 8s. 5d. per 1,000 gallons.

From an inquiry made a few years ago it was found that out of thirty-two towns that distinguished between the charges for combined residential and business premises and lock-up shops, the average charges made were respectively 83½ per cent. and 47¼ per cent. of the charges for domestic dwellings.

Now, the argument for these rebates, as they may be termed, is mainly based on the facts that in these cases less water is generally used than in the case of domestic dwellings, and that the rateable value is generally higher. But is this all that can be said on the matter?

What are the relative obligations of the domestic consumer and the trader towards the communal interests? As regards the public health they are identical except that the trader benefits to a much greater degree from the increased efficiency of his employees. And as regards the security of his property, the obligation is greater on the part of the trader because generally he has much more at stake. And what is the relative obligations from an individual point of view?

The domestic consumer uses his water mainly for the base necessities and amenities of life, which use is largely in the interests of public health, whereas the trader uses water as a raw material for the purpose of profit, indirectly if not always directly.

I am therefore of opinion that there are not sufficient grounds for a discrimination between the domestic consumer and the occupier of combined and residential lock-up premises.

What general principles are there to guide us in the sale of water by measure? First of all, the trader, whether he takes his water supply from the city in which he enjoys the profits of his trade or whether he does not, should pay a due and proper share of his obligation to the communal interests, and that share should be in some proportion to the extent of his business and his profits, or the rateable value of his property.

You cannot hope to get parliamentary powers to compel a trader to use the water supplied by a municipality even if you agree to supply water for trade purposes on demand, if the trader can prove that the water is unsuitable for his purposes; but you can hope to compel a trader who sinks his own well with the object of evading his obligations in the common interest to pay his proper share in the manner above described.

Fixing Charges

The charge per 1,000 gallons at which water should be sold bears directly on the cost of water, and in fixing approximately the amount that charge should exceed the cost we have to consider many interesting points.

(1) In the general interest of trade, the endeavor should be to sell as low as possible.

(2) The charges should be large enough to cover a certain amount of the loss in supplying the lower-rated domestic dwellings, for the reason that trade supply, being used as a means of private profit, should legitimately ease the burden of the domestic consumer in the comman interest.

(3) The charge, in my opinion, should be a flat rate, excepting in the case of very large quantities, and under special circumstances.

Commodities in general cost more in smaller packets because of the increased cost of handling and conveyance, and book-keeping expenses, etc., but this does not apply in anything like the same degree in the case of water, and, on the other hand, the small trader should have equal encouragement with the large.

(4) Water should not be sold below cost price. In exceptional cases, when it becomes a question of selling surplus water at a trifle below cost price or letting it go to waste, it is good business to sell it below cost. But in the sale of surplus water in large quantities, say, to outside authorities, the agreement should be for short periods only, for the city may require that surplus sooner than expected, and in that case considerable capital outlay will become necessary and a large surplus created for which there is no sale. The result is an increased cost of water within the city and a greater loss in sale outside.

Our aim should be not only to raise revenue for the purposes of water supply in the most equitable manner, but also in the simplest manner. We live in an age of heroic measures, when indeed no other measures will do—at a time when only the large vision, a strong imaginative grasp of the difficulties and their remedies, and a courage in proportion, will be of any avail.

Foundation of Local Taxation

The revenues for the purposes of water supply, like the other great public services, are raised on the annual value of the premises, and for this great principle we are indebted to the famous statute of the Poor Relief Act of 1601. Shortly after the passing of the statute the Judges of Assize declared that the assessments ought to be made according to the visible estate of the inhabitants both real and personal. Thus the standard of ability, or rather of rateability, was decided (in accordance with the obvious intention of the statute) to be visible estate. To avoid the mischief of a local inquisition into incomes was no doubt the aim of the legislature; and in accordance with this principle stock in trade was eventually exempted from valuation for rating purposes, so that "visible property" for rating purposes practically came to mean real property. Thus was laid the foundation stone upon which is built the whole structure of local taxation in England. Local expenditure is still defrayed by rates, rates are based upon the poor rate, and the poor rate is still governed by the principle laid down in this unrepealed statute of Elizabeth. It is not too much to say that there are few legislative achievements which can compare for simple grandeur and constructive foresight with the Poor Relief Act of 1601.

Some Proposals

Now, my point is this: Are we making the best use of this machinery for raising the revenue? What I should like to see is a wider and more intense application of this method applied to all properties in the area of supply.

A very few towns who have not the power to make a water charge under a private Act raise their revenue under the Public Health Act of 1875 as a part of the general district rate. In some cases a public water rate is raised on all rateable property irrespective of supply—for the

purposes of street watering and cleansing, sewer flushing, public fountains, baths and wash-houses, etc.—and in many towns where the limit imposed by parliament has been reached a "rate in aid" is made.

I am in favor of a public water rate varying in amount according to local conditions; of the rateable value being the basis of the minimum charge, and that the charges for trade supplies should be an addition to the minimum charge. I do not agree with differential rates, or, in other words, the rebates on higher-rated properties, opposed as they are to the fundamental principles of local taxation for public services.

To many, I am sure, some of my proposals will appear to be drastic. But if you look the problems before you calmly in the face, can you frankly say that the haphazard increase of this or that particular charge, based on narrow views, and without any reference to basic principles, is at all likely to be adequate in the solving of those problems?

FLEX-OR-CRETE NAILING COMPOSITION

A new nailing composition called Flex-or-crete is being marketed by the Flexner-Taylor Company, South Boston, Mass. It is a concrete through which nails can be driven, which is about half the weight of Portland cement concrete. It is being largely used as a sub-floor to which the top floor boards can be nailed, and as a sub-roof to which slate, copper or other material can be nailed.

The material is being used for the roof of the Parliament Buildings at Ottawa, sheet copper being nailed on top of it. At the Military Hospital, Whitby, Ontario, the material was used as flooring, on top of which linoleum was glued and nailed. The manufacturers state that they expect to put on the market partition blocks made of this material to which all woodwork, door trim, baseboards, etc., can be nailed without wood grounds. The material is also being used for wall plugging, replacing wooden plugs. It can be applied in plastic state over metal reinforcement for roof construction or wall construction.

In a test made last year for the Stone & Webster Engineering Corporation at the Massachusetts Institute of Technology, a small test slab of Flex-or-crete withstood a maximum load of 2,550 pounds, although a bad crack developed at 2,100 pounds. The load was concentrated at the centre of the slab, distributed to the slab by means of damp sand under a metal bar 2 inches wide. The slab was supported at the ends by metal bars 2 inches wide. The width of the span was 24 inches, length 30 inches and thickness 3¼ inches.

On compression tests of two cubes, each 8 inches x 8 inches x 8 inches, maximum loads of 116,600 pounds and 116,800 pounds respectively were withstood without cracks of any amount appearing before these loads were reached.

The manufacturers publish a table showing that the safe superimposed loads for flex-or-crete vary from 59 pounds per square foot for an 8-foot span (using 3 inches of flex-or-crete above the mesh, with steel of 0.173 cross-section area) up to 597 pounds per square foot for a 4-foot span (with 4 inches of flex-or-crete on steel of 0.277 cross-section area). Flex-or-crete slabs as thin as 2 inches can be used for 6½-ft. spans to carry 43 pounds per square foot, using steel of 0.173 cross-section area, while a similar slab of 4-ft. span will carry 104 pounds per square foot. The weight of one square foot of flex-or-crete one inch thick is six pounds.

METHOD AND COST OF CLEARING CUT-OVER LAND WITH POWDER*

UNDER a co-operative plan with the Land Department of the Potlatch Lumber Company, the Forestry Department of the University of Idaho has been carrying out extensive land clearing operations with a view of determining the most efficient methods.

The site selected for the operations was on level bottom land in the valley of the Palouse River, Idaho. The soil is classified by the U.S. Bureau of Soils as "potlatch silty clay loam with a tendency to be clayey." The soil was underlaid with a hardpan formation at an average depth of about 3½ ft. It had been covered formerly with a dense stand of western yellow pine. Douglas fir and western larch, in approximately equal proportions, as shown in the following table:

Percentage of Timber
(Ft diameter)

Plot No.	Red fir.	Yellow pine.	Tamarack.
1	35.7	30.5	34.7
2	49.3	23	27.7

Some of the pine had been cut eight years. Most of the tamarack and fir had been logged more recently; some only two years before. All except the smaller stumps were sound.

Two working plots each of five acres were carefully selected with the view of securing representative cost figures. Each plot was handled in exactly the same manner as regards preliminary work, the making of holes, piling and burning logs, brush and stumps, and leveling the ground after all clearing work had been done. The explosive used in Plot No. 1 was a 20 per cent. stumping powder; on Plot No. 2 a potassium chlorate powder equivalent to 60 per cent. dynamite was employed.

The number and per cent. of sound stumps in each plot were as follows:

Number and Per Cent. of Sound Stumps

Diameter.	Plot No. 1 Feet diam.	Plot No. 1 Per cent.	Plot No. 2 Feet diam.	Plot No. 2 Per cent.
6-in.	26	5	4	1
8-in.	12.8	2.4	7.8	1.7
10-in.	19.1	3.7	12.5	2.8
12-in.	3.1	6	2.0	4.7
14-in.	22.2	4.2	11.8	2.7
16-in.	38.8	7.1	40	9
18-in.	28.5	5.4	28.5	6.4
20-in.	48.4	9	26.6	6
22-in.	57	11	55	12
24-in.	46	8.4	24	5.4
26-in.	39	7.3	32.5	8
28-in.	30.4	5.7	21	4.8
30-in.	12.5	2.3	17.5	4
32-in.	21.4	4	26.7	6
34-in.	14.1	2.6	21.6	4.8
36-in.	24	4.5	15	3.4
38-in.	12.6	2.3	12.6	2.8
40-in.	6.7	1.2	6.7	1.5
42-in.	10.5	2	14	3.1
44-in.	18.3	3.4	29.3	6.6
48-in.	8	1.5	8	1.8
56-in.	4.6	0.7	9.3	2.1

*Abstracted from Bulletin of the University Agricultural Experiment Station.

A crew of from 4 to 6 men was used for the work of swamping and sawing, while two men with teams worked to best advantage after the material was cut up and rolled out where it was easily accessible. The large logs were thrown into heaps and constituted the base of all the piles. The lighter logs with limbs, brush and stump fragments were then thrown on top, completing the work preparatory to burning. The tools used were the axe, the cross-cut saw, canthooks, mattocks, shovels, augers, block and tackle, ⅝-in. wire cable, a snatch block open at the side to admit cable without passing the end through the block (a very great advantage), and a digger with a 3-in. cylindrical bit open on one side and welded to an 8-ft. handle of 1-in. gas pipe, which is an excellent tool, capable of cutting its way through roots and frozen ground. A battery costing about $18 with lead wires completed the outfit of tools.

Swamping, Sawing and Piling Logs, Brush, Etc.

The preliminary work consisted of swamping and sawing and placing all brush and unsound logs, limbs, brush, etc., in piles for burning. The cost of the preliminary work was as follows:

	Plot No. 1			Plot No. 2		
	Hours.	Rate.	Total.	Hours.	Rate.	Total.
Swampers ..	176	$0.25	$44.00	143	$0.25	$33.75
Sawyers	39	.25	9.75	44	.25	11.00
Teamsters ..	40	.25	10.00	19	.25	4.75
Teams	40	1.00*	4.45	19	1.00*	2.10
Feed	..	1.00*	4.45	..	1.00*	2.10
Total ..			$72.65			$73.70
Per acre			14.53			14.74

*Per day.

Locating and Making the Holes

One should have a good knowledge of the root system of the different species before undertaking this part of the work. Nothing is of more importance than determining upon the position, number, and depth of holes to be made under the large stumps. The exercise of proper judgment on these points will do more than anything else to reduce the amount of powder used and to secure the highest possible efficiency.

Large yellow pines generally have large, strong, and heavy tap roots. White pine and Douglas fir, as a rule, have no tap roots, but have large spreading laterals that are fairly easy to lift with properly placed powder. Larch roots are mostly lateral, but enter the ground obliquely and are hard to remove. Holes should run well toward the centre in yellow pine, intermediate for larch, and well toward the periphery of the base of the stump between the large laterals for large firs and white pine.

Various species tend to develop stronger tap roots on sloping, well-drained and aerated soils, than on level or mucky soils or in swamps. The laterals tend to be more oblique when growing under the former conditions than under the latter. These are important general rules which hold good for all species.

The number of holes to be placed under a stump in order to remove it completely and yet not waste powder was a point which received the most careful attention. One hole was found to be sufficient for removing stumps up to 18 ins. in diameter, while two holes were sufficient for removing stumps up to 30 ins. in diameter, and three holes for 40-in. stumps. Four holes were generally found ample for removing larger stumps, though for the largest five holes were sometimes found necessary.

The depth of the holes is also a very important feature and the success or failure of any blast often depends as much on the depth as on the location of the holes.

It was suggested that the vertical depth of the hole should equal the diameter of the stump. This rule was found to work well until the diameter of the stump exceeded 4 ft. It seemed that the sinking of the holes to a greater depth was of doubtful utility, at least for the soil conditions found on these two tracts.

In order to insure the perfect removal of the laterals it was found necessary to rupture an area of soil having a radius about three times greater than that of the stump, and in going deeper than 4 ft. the weight of the earth to be removed is so great as to yield unsatisfactory results. It was found, therefore, to be impracticable to go deeper than 4 ft. No more earth should be removed than is necessary in order to secure efficiency on account of the added expense of filling the holes. Holes should be deeper in sandy or dry, loose soil, and shallower where the hardpan is near the surface or where the ground is moist or well frozen on top.

The cost of making the holes for the powder was as follows:

	Plot No 1			Plot No 2		
	Hours	Rate.	Total.	Hours	Rate.	Total.
Boring holes.	152	$0.25	$38.90	168	$0.25	$42.00
Per acre			7.78			8.40

Placing the Powder

In loading the holes great care should be exercised relative to the proper amount of powder to be used under the stump and also to its proper distribution in the case of larger stumps. Here again the powder man must study the root-system and the slope and be guided accordingly. He must strive to place the powder in the various holes in proportion to the amount of work to be done in each place. The proper way to put a charge of dynamite into a hole is to split the cartridges down the side and cut them in two. This puts the powder into a small, compact space. The cap should be put into the end of a half unsplit stick, which should be placed well down in the charge in the hole. If electric fuses are to be used, a half hitch around the end of the cartridge is desirable in order that the cap may not be pulled out in tamping the powder and adjusting the wires. This tamping should be done firmly but very carefully with a wooden tamping stick until the charge is covered to a depth of 5 or 6 ins. The earth used in filling the remainder of the hole should be very firmly tamped, as the efficiency of the powder in a properly tamped charge may be nearly double that of one tamped in a loose and careless manner. One should remember that the force of the explosive depends more on the degree of confinement than on any other single factor, and any crevices or air spaces greatly reduce the power of the explosive; for this reason water is the best possible confining medium, but cannot be recommended for general use, since it is often not conveniently at hand. Waterproof fuse must be used in tamping with water and great care must be exercised to render the caps watertight around the fuse, by means of soap, tallow, or some other sealing medium.

When more than one charge is to be used under a stump, it is highly desirable to fire by means of electric fuses and a battery. This is because of the fact that it is nearly impossible in using the ordinary time-fuses to bring about all the explosions at the same instant. Since the efficiency of the powder and likewise the work, depends in a great measure on this one factor, it should not be neglected. Where one charge explodes before the others,

Table 1.—Average Amount of Powder Used for Each Size of Stump

Plot No. 1.

Diameter, ins.	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	48	52	56
Sticks powder	1	1.5	2	3	4	4.5	5	6	7.5	8.5	10.5	12.5	13.5	14.5	15.5	16.5	18	19	20	21	24	26	28
Pounds	.6	1	1.2	2	2.5	2.8	3.1	3.7	4.7	5.3	6.6	7.8	8.4	9.1	9.7	10.3	11.2	11.9	12.5	13.2	15	16.2	17.5
Pounds per ft. diam.	1.2	1.5	1.5	2	2.14	2.1	2.06	2.22	2.5	2.65	3.04	2.63	3.36	3.41	3.42	3.44	3.53	3.57	3.57	3.60	3.75	3.74	3.75
Cost per ft. diam. (cts.)	19	24	24	32	34	34	34	35	40	41	39	42	54	55	55	56	56.5	57	57	57.5	60	60	60
Cost per stump (cts.)	9.6	16	20	32	40	45	50	59	75	85	105	128	134	145	155	165	179	190	200	211	240	259	280

Plot No. 2.

Diameter, ins.	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	48	52	56
Pounds	7	1	1.2	2	2.5	2.6	3.3	4.2	5	5.5	6.2	7.5	8.1	8.8	9.3	10	11.5	12	12.5	13	15	16	17.5
Pounds per ft. diam.	1.4	1.5	1.5	2	2.14	1.9	2.2	2.52	2.7	2.75	2.86	3.21	3.26	3.3	3.28	3.6	3.63	3.6	3.57	3.54	3.73	3.69	3.75
Cost per ft. diam. (cts.)	24	25	25	34	36	32	37	43	46	47	49	55	55	56	56	61	62	61	60	60	63	63	64
Cost per stump (cts.)	12	17	21	34	42	44	56	71	85	93	105	127	138	149	158	170	195	204	212	231	255	272	297

its energy is expended in loosening the soil without removing the stump and the effectiveness of the other charges is thus greatly reduced, whereas if all are exploded at once each has equal lifting power because of the proper conditions of soil firmness under which each does its work.

Where only one hole is used in removing the stump it is cheaper to use blasting caps rather than electric fuse, and is usually as effective. This is true unless the stumps are so close together that the ground around others will be loosened. In such cases a battery should be used and the entire group fired at once.

The labor cost of the blasting was as follows:

	Plot No. 1			Plot No. 2		
	Hours.	Rate.	Total.	Hours.	Rate.	Total.
Powderman .	58	$0.35	$20.20	41	$0.35	$14.35
Helper	58	.25	14.50	68	.25	17.00
Total ...			$34.70			$31.35
Per acre			6.94			6.27

Strength of Caps

The lower the strength of powder the greater the strength of cap necessary to secure the greatest efficiency. This had been definitely determined by the United States War Department. Many persons make the serious mistake of using low-power caps because they are cheap. The War Department has shown that 40 per cent. dynamite is 15 per cent. stronger when a No. 5 cap is used than when a No. 3 cap is used; while the difference is only 6 per cent. when 60 per cent. dynamite is used. When several stumps stand together, electric fuses and a battery should be used, the stumps being connected in a series.

Quantity of Powder to Use

Great care was used to determine just the proper amount of powder necessary for different sizes and species of stumps. In general, one should so strive to place the charges under a stump, both in position and amount, as to exert a pressure under each main division of it sufficient to just throw the stump out of the ground. Either a larger or a smaller charge is wasteful. The use of an insufficient amount of powder cracks the stump and so loosens the soil as to make the final removal with powder costly. When a second blast is necessary more powder is often required to remove the shattered stump than would have been necessary to have completely removed the stump in the first attempt. For this reason it is always better to use a slight excess of powder as a factor of safety, thus insuring the removal of the stump at the first trial.

Since the efficiency of powder varies with the varying conditions of soil, moisture, stumps, etc., this problem must be worked out in a general way for each locality. A little careful study and experimentation in starting work in a new field will save much powder, time and labor.

Piling and Burning the Stumps

In piling the stumps, four men were found necessary with each team in order to secure the greatest efficiency. All the loose fragments were drawn to the log heaps and piled as high as possible by hand; sometimes separate piles of stumps alone were made when this was most convenient. A ginpole was not used as it was thought that by being careful to bring the larger fragments to the piles at first and while they were low, nothing would be gained

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Principal Contents of this Issue

THE COAL SITUATION

"City Coal Situation Worst of Winter; Supplies Gone, Zero Weather Threatened." That was the two-column heading which appeared a couple weeks ago in the New York Herald. New York is only about six hours' freight haul from the heart of the anthracite coal-mining region, yet the Herald article stated that "despite the activities of administrators, railroads and increased production at mines, the coal supply throughout New York has been steadily decreasing for days and the city never was worse off for coal than right now. . . . Thousands of families are moving from houses and apartments where fuel bins are empty. . . . Conditions in the poorer residential sections have made it necessary for the police to guard coal yards and administration offices since the last big storm. . . . While the coal supply obtained from New Jersey tidewater has averaged 22,000 tons daily, it was learned yesterday that a surplus of 70,000 tons, which had accumulated at the tidewater points ten days ago, has diminished, so that there is scarcely a day's reserve now awaiting transportation to New York."

When conditions are so grave in the most important city in the United States—a city almost bordering the coal-producing district—it is high time for Canada to look with alarm upon the fuel situation in Ontario, Quebec and Manitoba.

W. J. Dick, mining engineer of the Commission of Conservation, has estimated the lignite resources of Canada to be over one hundred billion tons, of which nearly two-thirds are in Saskatchewan. The Research Council desires to encourage the development of these lignite fields. Briquetted lignite is good fuel; the proposition is beyond the laboratory stage; it needs now only a full-size plant to determine whether it is commercially feasible. The Council has suggested to the Dominion government that an appropriation of four hundred thousand dollars be made with which to build a plant that will demonstrate how cheaply briquetted lignite can be sold under practical manufacturing conditions.

This grant should be made at once—from the last Victory Loan, as a war measure, if necessary. It is of the utmost importance to the efficient prosecution of war work in Canada that our fuel supply be ensured without householders being required to chop down shade trees. As Mr. Arthur V. White, consulting engineer to the Commission of Conservation and the International Joint Commission, said in an article in The Monetary Times Annual, recently published, statements to the effect that we cannot afford to produce and transport lignite because the selling price may have to be even a few dollars a ton more than imported anthracite coal, are simply ridiculous.

"Anthracite coal," says Mr. White, "due to war conditions, is now practically unobtainable in the countries of Western Europe. In the winter of 1916, for such coal as was available, France was paying about $40 per ton and Italy $50 per ton. Recent reports from these countries state that coal at present is selling at $60 per ton. Now, Canada imports annually about four and one-half million tons of anthracite from the United States. Suppose that circumstances prevailed for a year such as would make the citizens of Canada willing to pay even a fraction of the advance in European countries—say, $10 advance—this would amount to about $50,000,000. When one thinks in such terms of increased *yearly* outlay, surely a million dollars, or even a few millions of dollars if necessary, placed at the disposal of technical officers, assisted by men of sound commercial judgment, in order to get our own lignite and peat resources under national development, constitutes so intrinsically small a sum in comparison to the results as to be practically unworthy of debate."

Mr. White's argument is essentially sound. For many years he has studied and written about the fuel problem in Canada, not in its temporary aspect, but upon broad, national grounds. In the article above mentioned, which is well worth perusal by all who are interested in Canada's economic situation, he makes it clear that the government should take immediate and forceful action. The Research Council should have, without delay, all the funds that they can profitably use.

OUR NATIONAL DEBT

On October 31st, 1917, the net debt of the Dominion was $948,236,372. In 1913, before the war commenced, the debt was only $314,000,000. Thus there has been an increase of 200 per cent. in the debt. It is almost entirely due to war. The total increased by $47,000,000 in October last. At that rate, we shall have in March next a debt of over $1,000,000,000. At 5 per cent. per annum, the annual interest will amount to $50,000,000. This sum with a substantial amount added yearly for a sinking fund, can be met from the future revenue of the Dominion, provided strict economy be practised by governments and by the people of Canada. In national finance, if debts can be funded, the practical question is that of payment of annual interest. But while this is so, the fact must not be overlooked that debt is debt, a financial obligation

and burden upon the body politic, whether owed to investors at home or abroad.

Our war expenditures are approximately $1,000,000 daily. Up to July 20th, last, the war expenditure in Canada was $388,627,000 and elsewhere, $234,600,000, making the total to that date, $623,000,000. Since then, the war expenditures have been approximately $167,000,000, making a grand total of $790,000,000 to the end of 1917.

Dominion revenues for the seven months ended October last, of the current fiscal year, totalled $145,719,000, an increase of 11 per cent. over the corresponding period of the previous year. The gain was largely due to customs collections which changed from $75,000,000 to $91,763,000 in the seven months period of the two years respectively. Expenditures on capital account reached $144,213,352, of which $133,254,798 was due to the war, and $10,599,242 was on account of public works. In the previous year the war expenditure for the same period was $127,487,147, and the public works expenditure, $13,540,236.

PERSONALS

R. H. LONG has been appointed power superintendent of the Winnipeg Electric Railway. Mr. Long was formerly electrical superintendent.

JOHN N. TIMTURLAKE, formerly power apparatus sales engineer for the Northern Electric Company, has resigned his position to become Montreal district sales manager of R. E. T. Pringle, Limited.

Lieut. ALLAN LESLIE has been invested with the Military Cross. He is a graduate of the School of Practical Science, Toronto, and before going overseas was connected with the Bell Telephone Company.

W. J. WILKINSON, formerly manager of the Northern System of the Ontario Hydro-Electric Commission, with headquarters at North Bay, has accepted a position as manager of the North Bay Toy Company.

J. D. CUMMING, formerly with the Canadian Copper Company, Copper Cliff, Ont., has accepted the position of assistant to works manager of the Westmount plant, P. Lyall & Sons Construction Co., Limited, Montreal.

Lieut. ORVILLE DOUGLAS VAUGHAN, of the Applied Science Class, '17, formerly at the C.A.S.C. depot at Ross Barracks, Shorncliffe, Eng., has been discharged in order to undertake special work under the Ministry of Munitions.

Lieut. O. B. MCCUAIG, B.A.Sc., of the University of Toronto, has been awarded the Military Cross. Lieut. McCuaig was quartermaster-sergeant with the 2nd Field Company, Civil Engineers, and was later promoted to be lieutenant.

Lieut. ROBERT VERNON MACAULAY, B.A.Sc., has been awarded the Military Cross. He enlisted as bombardier with the Canadian field Artillery and was promoted to a lieutenancy on the field in June, 1916. He was on the headquarters staff during the winter months of 1916-17.

HARRY F. CLAYTON has resigned as works engineer of the Thor Iron Works, Toronto, and has accepted a position as Ontario representative of the Joliette Steel and Iron Foundry Company, Limited, of Joliette, P.Q., manufacturers of steel castings. Mr. Clayton has opened an office at 407 Lumsden Bldg., Toronto.

Major J. A. TREBILCOCK, a graduate of Forestry, class of 1915, School of Applied Science, Toronto, enlisted as a gunner with the C.F.A. He secured a commission in the Royal Field Artillery on reaching England. Since then he has been promoted first lieutenant, captain in April last, given the Military Cross in September, and now is serving in Italy with the rank of major in the Imperial forces.

OBITUARIES

WILLIAM EARLE, C.E., former manager of the St. John Street Railway, and latterly district engineer of Dominion Public Works in Manitoba, died last week.

J. H. SMITH, secretary-treasurer of the William Hamilton, Co., Limited, Peterborough, Ont., died Monday, January 7th, after very brief illness. He was a member of the City Council and the Board of Education.

Captain W. J. WILSON, a graduate of McGill University in civil engineering, class of 1913, was killed in action December 31st. He went overseas with the 74th Battalion as lieutenant in March, 1916, and later became attached to the 2nd Canadian Mounted Rifles. He won his captaincy on the field.

CHARLES UNWIN, Dominion and Ontario land surveyor, who died in Toronto recently, was born in Mansfield, Notts, Eng., December 30th, 1829. After having served as assessor for many years, he became city surveyor of Toronto in 1905, and held that position until 1910, since which time he had been on the city surveyor's staff as consultant. He studied his profession under the late J. Stoughton Dennis at Weston, Ont., and received his "certificate of admission as a provincial land surveyor in and for Upper Canada" on April 12th, 1852. One of the most important of his works was the survey of the Thousand Islands in the St. Lawrence River.

CAN. SOC. C.E., TORONTO BRANCH

That the members of the Toronto branch of the Canadian Society of Civil Engineers have shown considerable interest in the nomination of officers and members of committees for 1918, is evidenced by the fact that the following names will be submitted to the meeting to be held this evening, when officers and committeemen are to be elected:—

For chairman of the branch—Messrs. P. Gillespie (university), and A. H. Harkness (private practice).

For secretary—Messrs. W. S. Harvey (city), G. Hogarth (government), E. M. Proctor (private).

For committeemen, six of whom are to be elected—Messrs. J. R. W. Ambrose (railway), Frank Barber (private), E. T. Brandon (hydro), W. A. Birche (hydro), Willis Chipman (private), E. L. Cousins (harbor), W. Cross (harbor), F. A. Dallyn (government), T. U. Fairlie (hydro), R. Ferguson (harbor), N. R. Gibson (hydro), F. B. Goedike (harbor), H. A. Goldman (harbor), H. E. T. Haultain (university), T. Hogg (hydro), H. W. McAll (city), W. A. McLean (government), N. McLeod (contractor), J. Milne (city), P. H. Mitchell (private), E. G. Newsom (railway), J. N. Stanley (hydro), T. Taylor (city), E. T. Wilkie, F. Willsie (harbor), W. R. Worthington (city), R. O. Wynne-Roberts (private).

The following is an unusual accident which destroyed an oil distributor, tank and 100 ft. of road surface. A live coal, dropped on the road by the steam roller pulling the oiling equipment, ignited the hot-oil spray and set fire to the oiling equipment.

METHOD AND COST OF CLEARING CUT-OVER LAND WITH POWDER

(Continued from page 38)

by using the pole. Hanging fragments were removed occasionally with a second blast, but generally by means of the team and single block and cable. Occasionally two double blocks and a ⅞-in. wire cable were also brought into action, the single block being attached to the running end of the large cable from the double blocks. This arrangement proved to be very efficient, multiplying the power of the team approximately six times.

At first a few piles were made around large shattered stumps in the hope of removing them by means of fire, but this was found to be expensive and unsatisfactory, as the piles were consumed long before the stumps were burned out, and much labor and trouble were necessary in keeping the fires going till the stumps were consumed. In burning, it was found best to fire first a pile of stumps and logs here and there. This gave abundant live coals for readily kindling the remaining piles and proved a great saving of time. One man with a long-handled shovel could quickly have all the rest burning. As the piles burned out it was necessary to throw the material from the outer edges into the centre, until all was consumed and the ground thus left ready for leveling.

The cost of piling the stumps was as follows:

	Plot No. 1 Hours.	Rate.	Total.	Plot No. 2 Hours.	Rate.	Total.
Swampers ..	168	$0.25	$42.00	220	$0.25	$55.00
Teamsters ...	42	.25	10.50	52	.25	13.00
Teams	42	1.00*	4.65	52	1.00*	5.80
Feed	..	1.00*	4.65	..	1.00*	5.80
Total			$61.80			$79.60
Per acre			12.35			15.92

*Per day.

Leveling.

The larger holes were all filled by turning one or two deep furrows into them; then the balance of the field was plowed, and a large V-shaped road drag made of 3 by 12-in. planks was used for further leveling. This drag was equipped with a heavy ring on each leg at the rear and when alongside a large hole an extra team was hitched to this ring with a cable and the drag pulled sidewise, thus depositing the load of earth in the hole. This operation may be repeated from two or more sides if necessary. A metal plate fastened to the bottom of the drag and extending outward from 2 to 3 ins. will increase its efficiency. This method was found to be cheap and very efficient.

The estimated cost of leveling the ground per plot was as follows:

	Hours	Rate	Total
Teamsters	20	$0.25	$ 5.00
Helpers	20	.25	5.00
Teams	20	1.00*	2.00
Feed	..	1.00*	2.00
Total			$14.00
Per acre			2.80

*Per day.

The estimated cost of burning per plot was: One man 80 hours at 25 cts. or $20, making the cost per acre $4. The average amount of powder used for each size of stump is shown in Table I.

General figures on the clearing of the two plots follow:

	Plot No. 1	Plot No. 2
Area, acres	5	5
Number of stumps	479	365
Total feet diameter	703.3	674.7
Average diameter, ins.	14.4	21.2
Powder used, lbs.	1,678	2,000
Cost powder, cts. per lb.	16	17
Cost powder per ft. diam., cts. ..	39.3	50
Blasting holes, ft.	1,220	1,228
Cost blasting per ft. hole, cts. ..	.032	.034
Blasting caps, No. 5, No.	297	6
Electric fuses, No. 6, No.	340	595
Triple tape fuse, ft.	422	9

The final cost figures were as follows:

	Total cost Plot No. 1	Plot No. 2	Per acre Plot No. 1	Plot No. 2	Cents—Perft. diam. Plot No. 1	Plot No 2
Prelim. work	$72.65	$73.70	$14.53	$14.74	10.3	10.4
Making holes	38.90	42.00	7.78	8.40	5.5	6.2
Blasting ...	34.70	31.35	6.94	6.27	4.8	4.6
Powder	276.50	340.00	55.30	68.00	39.2	50.4
Caps	24.77	38.73	4.95	7.74	3.5	5.7
Fuse	4.22	0.09	0.84	0.02	0.6	0.0
Piling stumps	61.80	73.80	12.36	14.76	8.8	10.8
Burning ...	20.00	20.00	4.00	4.00	2.8	3.0
Leveling ...	14.00	14.00	2.80	2.80	2.0	2.1
Total	$547.54	$633.67	$109.50	$126.73	77.5	93.7

OXY-ACETYLENE AND ELECTRIC WELDING AND CUTTING PROCESSES IN LOCOMOTIVE SHOPS

(Continued from page 28)

punched by a countersunk die which gives the proper bevel for welding.

A great deal of trouble was experienced in welding in the superheater flues and tubes when it was first started, but after a little experience much better success was arrived at. Some operators prefer the tubes belled, and others prefer them beaded; some prefer the water in the boiler and others do not. The operators I am connected with like the belled methods best and with the water in the boiler. This keeps the tube sheet from heating, especially round the smaller tubes. Tubes are set in with copper ferrules set back 1/32 in. and the flues are belled out 3/16 in. to 7/32 in. and the small tubes 3/16 in. The sheet is roughened all round the tubes and flues, and the oil is then burnt off with the oxy-acetylene flame and tubes, and flues welded in with electrode, using ⅛ in. mild steel or Swedish iron; the latter is preferred if caulking is needed.

For cutting steel and wrought iron, the oxy-acetylene process has practically no competitor, it being impossible with the carbon point to cut as fast, or as fine and neatly, as the gas torch, although for scrapping fireboxes and frames, the carbon point is cheaper, if time is no object and labor cheap.

A new wood, called balsa, growing principally in South and Central America, is remarkable on account of its lightness, microscopical structure, absence of woody fibre, elasticity and heat insulating qualities. So far as investigation has disclosed, it is the lightest commercially useful wood known. It has also considerable structural strength, which makes it suitable for many uses.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Demolition of the Ragged Rapids Dam

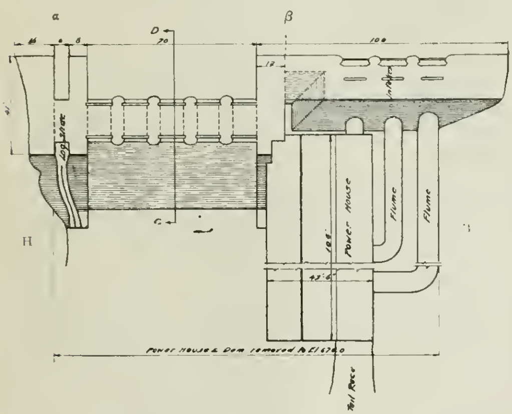
Removal of Obstructions Necessitated by Inclusion of River Severn in Trent Canal System—Reinforced Concrete Dam Dynamited Under Full Head of Water

By SIDNEY BOWEN

Resident Engineer, Inland Construction Company, Limited

WHEN it was decided by the Department of Railways and Canals to make use of the River Severn as part of the Trent Canal system, consideration had to be given to the fact that the dam and powerhouse at Ragged Rapids obstructed the route.

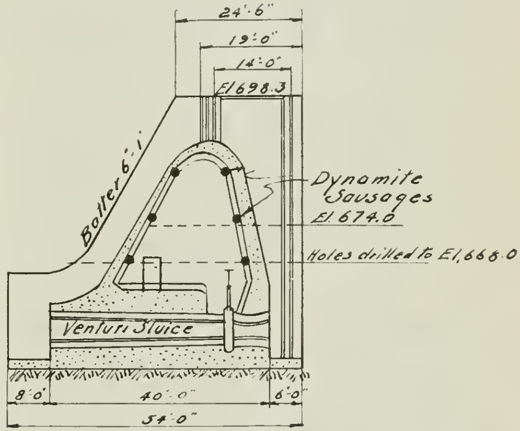
Various plans were considered as to the best means of overcoming this difficulty, it being finally decided to build a new dam, powerhouse and lock at Swift Rapids, about 1½ miles downstream, and to remove the present power development. If only the piers from the deck to the spillway level had to be removed, the problem would have been one of extreme simplicity, but as the water coming down the river during the spring freshet amounts to quite an appreciable quantity, reaching a maximum of about 10,000 sec.-ft., it was deemed advisable to remove the whole development to a depth of 24.3 ft., *viz.*, from elevation 698.3 to elevation 674, thus giving an area of about 4,000 sq. ft.



Plan of Ragged Rapids Dam

The contract for that portion of the canal known as Section 2, Severn Division, Trent Canal, was awarded to the Inland Construction Co., Limited, who decided to call in Mr. Russel, of the Canadian Explosives, Limited, Montreal, to consult with the writer as to the best methods to be employed to obtain the desired result.

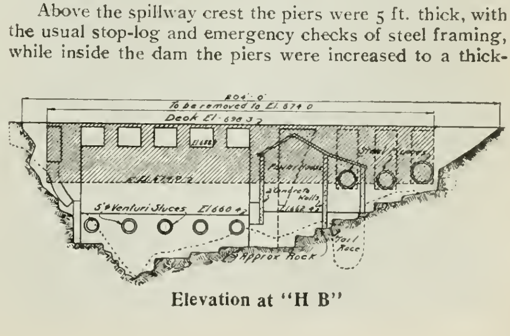
The dam in question was built about 10 years ago (to replace a dam which had proved unsatisfactory) to the plans, specifications, and under the direct supervision of Mr. J. B. MacRae, consulting engineer, Ottawa, and since that time had been used to impound water necessary for generating power for the use of the town of Orillia and surrounding districts, having been constructed to withstand a head of 46.5 ft., the head water being at elevation 697.5 and tail water at elevation 651.0, regulated level.



Section at "C D"

As shown on the accompanying plan, the dam consisted of a series of five spillways, each of 10 ft. opening. An abutment 30 ft. thick or thereabouts, containing a log-slide 6 ft. wide on the north side, and a gravity wall 12 ft. thick on the south side, connected to the open penstocks and steel flumes by means of a gravity wall 7 ft. thick at deck level, with the downstream face sloping five inches to the foot.

Above the spillway crest the piers were 5 ft. thick, with the usual stop-log and emergency checks of steel framing, while inside the dam the piers were increased to a thick-



Elevation at "H B"

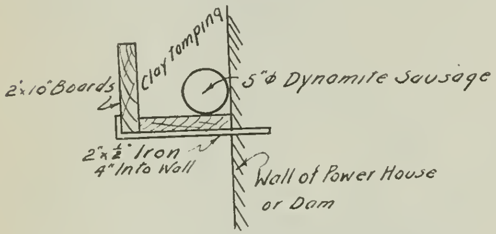
ness of 6 ft., with an opening in each to give access to the Venturi sluices, of which there were five, *viz.*, one under each spillway.

By thus increasing the thickness of the piers inside, a ledge 6 ins. wide was left on the upstream face of each pier and against this was placed a heavily reinforced concrete curtain wall, varying from 36 ins. thick at the floor level to 30 ins. thick at the top of the spillway. It will therefore be noted that the reinforcing did not pass into the piers at all, the only connection between curtain wall and piers being the above-named ledge and some stop-water timbers, half in one and half in the other. On the other hand, the curtain wall on the downstream simply rested on the piers, the reinforcing passing directly from end to end of the dam and into the abutments.

The deck of the dam consisted of a 6-in. slab of concrete in which was embedded expanded metal and 25-lb. rails for stop-log winches.

The penstocks require little or no description as they were simply steel flumes passing through a concrete gravity wall, with emergency gains of steel framing and gates, as shown on plan.

The power house itself was contained by six walls, each built of concrete (not reinforced) and about 2 ft. thick, arranged as shown on plan with steel roof trusses



Detail Showing Method of Using Dynamite Sausage

built into the concrete and covered with 2-in. lumber and wood shingles.

The time for completing the work being short and the authorities being anxious to get the new plant into operation, the company decided to meet their requests so far as lay in their power and therefore concluded to remove the dam and power house in three operations instead of two, as first intended, *viz.*, 1st, power house; 2nd, dam between the points marked α β on plan, and 3rd, the remaining intakes as convenient.

Demolishing the Power House

In order to ascertain the best way to remove the power house, holes about 6 ft. apart and half-way through the wall were dug in part of one wall. Two to four 1½-in x 8-in sticks of 60 per cent. N.G. dynamite were placed in each hole and mudcapped. These charges were exploded together and it was found that the dynamite broke through the wall and, while shaking and cracking it, did not break from hole to hole, and the walls, being held up in place by the roof trusses, did not fall. The following plan was therefore adopted: 10-in. x 2-in. boards were arranged in angle formation as per sketch and fastened to the wall at a sufficiently low elevation to permit of convenient working, and about 6 ft. below level of demolition. Straight dynamite, 60 per cent., arranged in bundles of five cartridges with a No. 6 electric blasting cap in each bundle, were placed in the boards and against the wall, leaving a space of about 2 ft. between each bundle, the bundles of explosives being pressed against the concrete by means of clay tamping, in other words, "mud-capped."

To fire the charge, the electric blasting caps were connected with the leads in series of ten, the whole being set off by throwing in a switch connecting to the 100-volt leads, which were close at hand. The result was all that could have been wished for, the walls being cut clean and the whole power house collapsed as anticipated.

In 1½ hours, five men placed and mud-capped the charges used to demolish the power house walls. Approximately 200 ft. of wall was thrown down.

Preparations for Dynamiting the Dam

When blasting out the dam, the abutment on the north side of the river, the four piers and the south gravity wall, all between the points marked α and β, were drilled to a depth of 30 ft. and in such way that the distance between each hole at the bottom was 4 ft.

A piston drill was used for drilling the holes; seventy holes being drilled in approximately 45 machine shifts of 10 hours each.

Now, instead of drilling holes in the upstream and downstream curtain walls, an operation which would have been tedious and expensive, if not almost impossible, owing to the network of reinforcing iron, instructions were given to procure 10-in. x 2-in. boards, nailed firmly together in the form of an L and arranged and supported against the inside of the curtain walls by means of 2-in. x ½-in. brackets. These angles were to be placed at 8-ft. centres, the first ones being at the same elevation as the bottom of the 30-ft. holes, thus accounting for six L's for each spillway, as per sectional elevation.

Loading the Dam

On November 9th, 1917, all necessary preparations having been made in advance, such as clay tamping, etc., a start was made to load the inside of the dam, which, being dry and warm, would not have any bad effect on the dynamite.

Canvas bags, 5 ins. in diameter and 9 ft. 0 in. long, were loaded with 14 bundles of 60 per cent. straight dynamite; each bundle contained 12 cartridges and were placed in the angles already prepared, and two No. 8 waterproof electric blasting caps were connected with each bag, one at either end.

Clay tamping was used to press the charge close up against the walls, as was done in the case of the power house, so as to obtain the maximum amount of work.

This was done for the six bags in each of the five spillways and great care was taken with the tamping as, although it has not been mentioned so far, a full head of water was against the dam and therefore the explosive had to work not only against the concrete reinforcing, but also against the water, which would minimize its effect to a great extent.

It was not thought advisable to flood the inside of the dam, as fears were entertained that the water might creep in between the bags and the wall, which might or might not have been disastrous.

On the morning of the 10th, loading of the holes was started from the deck and 60 per cent. polar forcite gelatine was used. The whole operation of loading was completed by 4 p.m.

The object of using two kinds of explosive for the work was as follows: To cut off and break up the reinforced concrete by mudcapping and to start it moving before the piers were smashed, an explosive of high velocity was necessary, so C.X.L. 60 per cent. straight dynamite was

used (C.X.L. forcite gelatine being of equal strength but with a lower velocity of explosion) so that the dynamite would not only break up the piers, but also heave the debris a certain distance, so that the rushing water could easily wash it away. The polar variety of forcite does not freeze until a low temperature is reached, so that although the work was done in November, the forcite needed no thawing.

All that now remained was to connect up the electric blasting caps, 150 in all, with the leads. This was arranged in multiple series of 15 caps each. Two pairs of 14-gauge copper lead wires were used; one pair took the caps from the holes in the piers and the other pair took the caps from the charges in the inside of the dam. One pair was then connected to the other at the river's edge and one pair ran from this junction to the switch. In this way the electric current reached the two sections of the blasting charge at practically the same instant, preventing cut-offs.

A 500-volt alternating current was used to explode the caps, the switch being thrown by Mr. Russel at 4.30 p.m.

The result obtained was all that could be desired, the dam being completely demolished within the lines intended, not a vestige of concrete, rock or reinforcing being seen, the water having done its work of sweeping the debris away in excellent fashion.

Contrary to expectations, very little jar was experienced. The explosion was very muffled, being due no doubt to the two different forms of dynamite used and the variation in the speeds in which they did their work.

RAILWAYS WILL GET NEW RAILS

According to a press despatch sent from Ottawa, an increase of 20 per cent. in the steel production of Canada over that of last year is promised as the result of conferences held between the War Committee of the Cabinet and the Canadian steel manufacturers.

The immense amount of steel required for the manufacture of munitions has prevented the railways from securing rails from the Canadian mills. While in some cases they had contracts with the steel companies for the manufacture of rails, the railways have waived their claims to permit the fullest possible manufacture of munitions. The railways, however, could no longer continue without a supply of rails for maintenance purposes, therefore the government called the manufacturers into conference.

In a discussion of his own paper on "Multiple-Arch Dams of Rush Creek, California" (Proceedings Am. Soc. C.E., September, 1917), Mr. L. R. Jorgensen states that "good concrete is fairly watertight and gunite is remarkably so." He says:—

"Some tests were carried out in the laboratory of the University of California on the watertightness of plaster 'shot' on the dam face with a cement-gun. Several plaster slabs, from ⅜ to 1½ ins. thick, made at Gem Lake, were tested with water pressures ranging from 700 to 1,600 ft. for several hours, with no moisture coming through the slab. One 1-in. slab held a head of 1,610 ft. for 2½ hours without showing moisture, then the water pressure was raised gradually to 3,400 ft., and the specimen broke in bending, having leaked a little just before breaking.—From Engineering-Contracting, of Chicago.

REPORT OF THE COUNCIL OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS

The council of the Canadian Society of Civil Engineers have prepared a report covering the year 1917, which will be submitted to the membership at the annual meeting to be held next week at Montreal. The report includes the financial statement, additions to and removals from the membership roll, an outline of the society's activities during the year, and the report of the library committee. Following is an abstract of the council's summary of the year's activities:—

The suggestion of the president that an executive committee of the council be formed was carried into effect, and this committee, consisting of the president, the local vice-presidents and the chairmen of the committees of council, handled a large part of the detail, the results of these committee meetings being submitted to council in the form of a series of recommendations from the executive.

A legislative committee was appointed to look after all legislative matters affecting engineers, consisting of three members of council, through whom three members of each branch co-operated. The legislative committee's report to council has shown that this departure was an important development in its relation to the society's future.

The importance of the maritime provinces as centres of engineering activity has been considered and the initial steps taken towards the establishing of branches there, it being intended that immediately after the annual meeting the arrangements already instituted will be successfully completed.

Recognition of the great part members of this society are playing in the world war has been exemplified in the preparation and completion of an honor roll containing eight-hundred and fifty-nine names; all of whom have sacrificed much and many of whom have sacrificed all for the world's civilization.

A committee has been appointed to report on a form proposed to be sent to the membership in order to have on file at headquarters a complete and up-to-date record of the professional career of each member, in order that the society may be in a better position to be of service to the individual.

Following the newly adopted policy of the society to engage in useful public service, the decision of the council to co-operate with the Honorary Advisory Council for Scientific and Industrial Research, resulted in the membership at large taking an active part in assisting the Research Council to distribute an industrial questionnaire, the major portion of the detail for Montreal and Quebec being handled from headquarters office.

The spirit of closer affiliations with other organizations has been exemplified in the invitation from the Institution of Civil Engineers, extending to members the use of the Institution's library and reading rooms, and the cordial resolution of the Board of Direction of the American Society of Civil Engineers.

The completion of the Quebec Bridge during the past year, erected from designs and constructed under the direction of members of this society, is an achievement worthy of a permanent place in the society's annals and it is intended to place at headquarters a memorial commemorating this event.

It is with deep regret that council records the death of the late secretary, Professor C. H. McLeod, who for twenty-five years, as secretary and member of council, took a leading part in the direction and development of this organization, and whose sudden passing is a real loss to the society and the engineering profession.

MANITOBA ENGINEERS DISCUSS POSSIBLE ENGINEERING LEGISLATIVE ENACTMENTS

THE executive committee of the Calgary Branch, Canadian Society of Civil Engineers, recently submitted for the consideration of the other branches, a resolution regarding possible Dominion legislative enactments defining the status of engineers. The Manitoba Branch of the society met two weeks ago to discuss the Calgary resolution, and as a result of the discussion forwarded the following resolution to the council of the society:—

"Resolved that it is the consensus of opinion of the Manitoba Branch of the Canadian Society of Civil Engineers that some organization and legislation be consumated for the purpose of defining the qualifications of an engineer and in the line of organization would suggest the following:—

"That the council at the general meeting in 1918 be authorized to devise ways and means to obtain with the help of the kindred societies, a census as complete as possible of all the professional men engaged in any class of engineering work in Canada and at the Front. When this is done and the men properly classified according to their age, education, training and achievements, that the council be authorized to arrange with the kindred societies to gather all these engineers worthy of the name, under one flag, which would be that of the Engineering Institute of Canada, and carefully enact new by-laws which should be strictly adhered to. This in order to show that this country possesses in the engineering profession a potential strength ready to be conscripted by the government, who should make full use of it not only to do its full share in helping to obtain a speedy victory for humanity, but also, after the war, to make this Dominion one of the foremost countries of the world."

Commenting upon the above resolution, J. G. Legrand, M.Can.Soc.C.E., bridge engineer of the G.T.P., Winnipeg, writes to *The Canadian Engineer* as follows:—

"It is instructive to note the wording of this resolution, which would seem to show that the majority of the members present at the meeting were not quite clear in their minds as to what precisely constitutes an engineer, and desired legislation to define for them the qualifications necessary for an engineer. But I know that a definition of the qualifications of an engineer was not the only advantage expected from legislation by the majority of the members present.

"If engineering is to be put on the same footing as law, medicine, etc., the necessary legislation should, it seems to me, contain the following main clauses:—

"1st. A correct definition of what constitutes an engineer. In order to obtain this, the main divisions of the engineering profession should be consulted.

"2nd. An accurate estimate of the minimum amount of knowledge, both technical and practical, required for the different grades of membership in each division.

"3rd. The appointment of a governing body composed of legal men chosen by the members of the Institute belonging to the different divisions of the engineering profession. This governing body should have powers corresponding to those of the governing boards of law, medicine, and so forth.

"In conclusion I should say that the seeking of legislation should be done in the broadest spirit, in order to offer the public at large a profession in which they could have full confidence."

Mr. Legrand had been asked to uphold the negative side of the discussion as to the advisability of seeking Dominion legislation for the purpose of bettering the standing of the engineering profession in Canada. In part, Mr. Legrand's speech was as follows:—

"The question of legislative enactment to place the engineering profession on a footing similar to that of the other professions, such as medicine, law, surveying, architecture, etc., is not new. It was taken up some years ago when there was so much public work being done in this country, but in those days the engineers were kept so busy that there was no time left to look after their own personal interests. But now this state of affairs has been greatly modified, particularly during the past three years, in which there has been a decided decrease in public works.

"The progress of the war has, however, changed the conditions so materially that our profession is coming more and more into prominence every day.

"There is no doubt in my mind but that the engineering profession, especially at this time, should be considered supreme in the professional realm.

"It is the duty of the engineer—I call an engineer a man who devises ways and means and plans the various public and private works necessary for the comfort and well-being of his fellowmen—to demonstrate to the public that he is a man of inventive ability, ready at all times to do them service, and on whom they can rely as a true friend.

"It seems most extraordinary that it should be necessary to explain to any one that even the ordinary comforts and conveniences utilized from day to day, such as transportation, lighting, heating, clothing, home facilities, food, etc., in fact, everything entering into the daily routine of an ordinary man's life, emanate from the brains of engineers.

"It is an undoubted fact that the public at large are not in a position to understand or appreciate the work done by our profession, but the reason for this is that we engineers do not sufficiently inform the public of our doings.

"The engineering profession embraces such a wide field that it has necessarily been divided into quite a number of classes, such as general engineering, embracing railways, highways and canals, etc.; mining; hydraulic; naval; aeronautical; chemical; structural; mechanical; electrical engineering; and so forth. All these classes are of equal importance and are so intimately governed by the same general principles that one cannot progress and develop without the help of all the others.

"'Noblesse oblige.' That is, 'Position and standing impose obligations.' The obligations of a man who chooses the engineering profession involve hard work at all times in order to improve not only scientifically but socially as well. He must read the best authors and learn how to speak clearly in order to show himself to the best advantage. Further, he must live a clean life, both from the physical and moral standpoint, so that he may enhance the value and reputation of his profession and ultimately bring it to be looked upon as 'The First of the Professions,' the position which is rightly hers.

"With such ideals, which should be inculcated in college, the engineering profession will not need any legislative enactment. Indeed, let me remark, as I close, that legislative enactment as applied to the other professions has certainly not improved either their moral or their material standing."

REVIEW OF NEW SPECIFICATIONS FOR STEEL HIGHWAY BRIDGES

By Geo. Hogarth, A.M.Can.Soc.C.E.
Engineer of Highways, Ontario.

THE General Specification for Steel Highway Bridges which has been prepared by a committee of the Canadian Society of Civil Engineers, is very comprehensive and complete, and covers the construction of highway bridges carrying the ordinary highway traffic or combined highway and electric railway traffic.

The various chapters are: Introductory; General Features; Floor; Loads and Stresses; Unit Stresses; Proportioning of Parts; Details of Design; Movable Bridges; Workmanship; Materials; Full-Sized Tests; Inspection and Testing at the Mills; Inspection and Testing at the Shops; Painting, Creosoting and Asphalt; Motor Truck Loads; Electric Car Loads; Detail of Wooden Handrail; Data to be Supplied by the Engineer; and Index.

An examination of the specification shows that a broad choice of loadings for bridges is presented. A new heavy loading, noted as Class "A", consisting of a 25-ton motor truck is suggested. This is along the lines of present-day tendency in motor truck design. Such loading is proposed for manufacturing districts in cities. A concentrated loading of 15 tons is proposed in residential districts in cities and towns, while the same concentrated loading is proposed for country highways. A new light loading for mountainous districts is very useful, and consists of a concentrated load composed of a 6-ton motor truck, with a uniform load of from 70 pounds per square foot for 50-foot spans and less, diminishing to 40 pounds per square foot for spans 200 feet and over. The T-chord design is recognized and approved for spans up to 80 feet, for structures in mountainous districts, and in such structures metal ¼ inch thick is also permitted. A slight change has been made in the requirements for strength of handrail posts, which would accordingly be reduced slightly in size. Planking of sidewalks may have ½-inch open joints which would hardly seem desirable on account of small objects being able to pass through the floor.

Creosoted timber flooring is recommended for all bridges requiring a small dead load. The application of impact stresses has been changed so that the impact is only added to stresses produced by the concentrated loads. In the case of motor truck loads 30 per cent. of the computed stresses is added for impact, while for electric car loads the usual formula is given. The distribution of the concentrated wheel load on the floor is given, specifically, and results in rather heavier loading than used in present practice.

A departure from present specifications has been made in the column formula which as proposed is $12{,}000 - 0.3 \left(\frac{l}{r}\right)^2$ in pounds per square inch. The stress allowed on steel castings has been reduced, while an allowable compressive stress on iron castings has been included. Unit stresses in bending are also given for steel and iron castings, while allowable stresses for bending in timber is included. Present-day improved shop and field methods in the driving of rivets have been recognized by increasing the shearing and bearing value for such rivets. Hard bronze expansion bearings are recommended, and the unit stress in bearing for such members is given. Granite masonry has been allowed a bearing pressure of 800 pounds per square inch, and the bearing capacity of concrete has been increased.

In arriving at the net section of tension members, a minimum of at least two rivet holes must be deducted. The size of compression members has been reduced, and it is proposed to permit a length of 175 times the least radius of gyration. A formula for the minimum thickness of cover plates and web plates in compression and also for the minimum thickness for unstiffened flanges of compression members is given. Bridges less than 50 feet in length and composed of T-chords may have single web trusses. The design of connections for all members is definitely settled by requiring that such connections be detailed for the net sectional area of the member and the allowable unit stress on that area is given. Diaphragms are required in the ends of certain sizes of compression members and such a detail is desirable in the interests of stiffness of the member. The design of the latticing of compression members is to be based on the stress in the member, and such latticing shall resist cross shear equal to 2 per cent. of that stress.

The minimum size of expansion roller is to be increased from 3 to 4 inches, while plates for expansion bearings of spans 80 feet and over are to be of hard bronze or other non-corrosive material. Spans of 100 feet and over are to be preferably supported on hinge or disc bearings.

A very satisfactory paragraph containing some 47 clauses covers the complete design of movable bridges, and brings the design of such structures up to date.

Under "Workmanship" it is stated that rivet holes must be drilled from the solid or sub-punched and reamed. This marks a step in the proper direction that all shop work should take and undoubtedly connections under this specification should have a much better fit.

The other paragraphs on materials, tests, inspection and bending are composed of the usual general clauses, and the last three or four pages are taken up with diagrams of concentrated loads, dimensions of handrail details, data required and the index.

U.S. POWER DEVELOPMENT BILL

The United States Administration Water Transportation and Power Development Bill, which is designed to inrease transportation and power facilities, is ready for introduction into Congress.

The bill creates a commission, composed of the Secretary of War, Secretary of Agriculture and Secretary of the Interior, to have charge of developing the country's water power.

President Wilson is authorized to appoint an executive officer for the commission through whom its policies shall be carried out. He is to serve for five years at $10,000 a year. He is given power to issue licenses for construction of dams, reservoirs, power houses, transmission lines or any other projects which will aid in power development or improve navigation. Licenses are for fifty years. Licensees must submit all plans for improvement to the commission, which may alter them if it sees fit.

The federal government is to be given free power to operate locks. If the government wants any power plant for manufacture of explosives or fixation of nitrogen to use in explosives manufacture, the bill empowers the commission to commandeer such plants. Rates to be charged for power are subject to regulation and reduction by the commission, to which they must be submitted.

NOTES ON WATER SUPPLIES AS SOURCES OF POWER*

By Cecil H. Roberts, M.Inst.C.E.
Water Engineer, Aberdeen, Scotland.

IN few branches of engineering has progress been so rapid as it has been, for the last few years before the war, in water power engineering. Not only have the design and efficiency of water turbines and generators of electricity been greatly improved, but the transmission of power to considerable distances by high-pressure three-phase alternating current has become a comparatively simple matter. Owing to the great advances made, and to the demand for power which is to-day almost insatiable, many water power schemes, considered impracticable 20 or even 15 years ago, must be now possible and ready for development.

In Italy, no doubt owing to the limited supply of coal available in that country, there are at present some 400 large water power schemes which are apparently giving every satisfaction, and the total water power already harnessed is stated by Dr. Liuggi to be some 1,300,000 horse-power. Water power has also been considerably developed in Sweden, Norway, Spain, France and Switzerland, and other European countries. In Switzerland, electric power from plants of moderate size is distributed in the rural districts and used for agricultural purposes. Under favorable conditions, water power can be obtained at 40s. and less per horse-power per annum. Many large water power schemes have also been carried out in the United States and in Canada.

The subject of water power can hardly, perhaps, be so important in this country, where coal of good quality is so easily obtainable, as in countries where coal, oil, and other forms of fuel are more costly and difficult to obtain. Nevertheless, there are several important water power installations in the British Isles, among which may be mentioned: (1) The Kinlochleven Works in the West of Scotland, the present capacity of which is 30,000 horse-power, with provision for extension; (2) works of about one-fourth this capacity at Foyers; (3) the works of the North Wales Power Company, in the Snowden district, which supplies a number of large quarries; (4) works at Conway, in connection with which an Act of Parliament was obtained last year (1916), authorizing the linking of the works with the water supply works of the Conway Water Board; and (5) an installation at Chester, where power is obtained from the River Dee, the head utilized varying from about 1 ft. to 9 ft. This latter plant is understood to be capable of supplying power at a maximum rate of about 500 horse-power, depending on the discharge of the river. The works are linked up with the steam plant of the Chester Electricity Works, the cost of the current obtained from the water power plant being much less than that of the current generated by the steam power plant. There are also some small works in Ireland.

Although there is not very much water power available for development at a remunerative cost in this country, owing to the smallness of the rivers, the scarcity of large lakes at high elevations, and the necessity generally of building costly storage reservoirs, the total being estimated at about 1,000,000 horse-power, there is likely to be a great development of water power in other countries, such as Canada, Australia, New Zealand, Africa, India, Mesopotamia, South America, as well as in Europe after the war, and the subject should not be neglected by water engineers who desire to share in the pioneering work to be done in other countries than Britain. The subject should also be interesting to such manufacturing firms as may be in a position to provide the hydraulic and electrical plant which will be required.

Mechanical power of all kinds is destined to take a more important place in the future activities of the world than it does at present, and water power will become especially valuable owing to the increased cost of coals, oils, and other fuels.

Quite apart from the hydraulic power supplies at high pressure, it is, of course, common for water undertakings to supply water power within their areas of distribution for operating hydraulic lifts, and small water motors used in various trades, but in recent years this demand has been seriously diminished by the competition of electricity, which, at a charge of 1½d. per Board of Trade unit—the charge for large powers is often much less than this—or about 1⅛d. per horse-power, is equivalent to a charge of less than 1d. per 1,000 gals. of water under a head of 150 ft. It is not, however, feasible for waterworks to make such very low charges for the supply of power from their distribution systems.

Low electric power charges are, no doubt, due very largely to the desirability of cultivating power loads to neutralize as much as possible the effect of high peaks on the station load diagram, due mainly to the lighting loads. The generating station plant has to be large enough to deal with the peaks and the power loads designed to fill the gaps or valleys can be accepted at charges approximating to the running costs of the plant, which are often little more than one-third of the total costs of current.

The load or supply factor (*i.e.*, the percentage of average to maximum load) has a much less important influence on the costs of supply in a waterworks where the power can be accumulated in elevated reservoirs, and there is little advantage to be gained in encouraging power loads in preference to supply loads by selling water power from the distribution mains at a lower charge.

On the other hand, the question of load factor in a public supply electricity generating station in connection with the ability to accumulate power possessed by a waterworks appears to suggest certain advantages in the combination of electricity and waterworks, as for example, in pumping into a service reservoir. A regular all-day pumping load dovetails very satisfactorily into an electricity generating station load, especially if the pumping can be discontinued during the period of peak load, as is possible in some cases. Another factor which suggests advantage in combining electricity and waterworks is that the consumption of water for ordinary purposes is generally lower in the winter, when not only is the available supply of water greater, but the consumption of electricity is at its maximum, and coal supplies are in more general demand.

Many waterworks are in a position to generate power from the water before it reaches the service reservoirs, and in some cases, especially in districts far from coal supplies, water power could be generated and supplied at a reasonable cost. Some watersheds are capable of supplying as much as 100 million gallons of water per day from a considerable elevation, and the difference in level between the impounding reservoirs and the service reservoirs varies in different waterworks up to and over 500 ft. Of course, there must be many cases where the cost of the works necessary to utilize power externally would be out of proportion to the available revenue which it would command, but, on the other hand, there would be other

*From a paper read before the Institution of Water Engineers, December 7th, 1917.

cases where it would be decidedly advantageous to so modify the design of waterworks as to bring some of this water power into external use, and seeing that every 1,000 horse-power developed by the combustion of coal absorbs some 10,000 or more tons of coal per year, it is evident that the use of this asset would be to the national advantage.

In most upland waterworks a large proportion of the water caught in the impounding reservoir overflows in the winter, and the power from this, as well as that available from the compensation water, is generally wasted. A further loss of power is caused by throttling the outlet valves of the reservoir, the amount lost varying with the season, and being greater in the winter than in the summer.

As an illustration, it may be pointed out that, assuming the surplus power available between the impounding reservoir and the beginning of the aqueduct amounts to 500 horse-power, this could be utilized to operate turbines driving direct-current or alternating-current dynamos, and the electric power so generated (which could, if necessary, be transmitted to a considerable distance) would be sufficient to provide all the light and power required by a town of considerable size and importance, and the revenue obtainable, with very reasonable charges, would be in the neighborhood of £15,000 per annum, sufficient to warrant a substantial outlay of capital on the necessary works.

A further advantage of combining power plant with upland waterworks lies in the fact that, as storage works on a large scale are often an essential part of a waterworks, a small proportion only of the cost of such works would be chargeable against the power scheme, and the outlay on pressure pipes, which would probably be comparatively short in length, ought not to be heavy.

In some cases where suitable loads can be obtained, it should be possible to harness for power purposes most of the floods, and thus to utilize a large proportion of the mean rainfall, instead of only the average of three dry years, as is the case with waterworks alone.

The idea of utilizing surplus water power in upland waterworks is not by any means new. A proposal to use for lighting and power purposes the power (about 400 horse-power) available at the Longdendale works of the Manchester Corporation was reported on by Sir Alexander Kennedy as long ago as 1899; although nothing was done at that time, hydro-electric works have since been constructed for utilizing some of the power locally by Mr. Holme Lewis, the present water engineer of Manchester. Dr. Deacon, in 1902, described how a portion of the surplus power in the aqueduct of the Vyrnwy works was utilized at Oswestry to operate "Brotherton" engines. More recently, in the Birmingham waterworks, water turbines and dynamos have been installed for using a portion of the power available in the compensation water.

When the difference between the level of the impounding reservoir and that of the town to be supplied is considerable, it may be at times possible, without prohibitive additional cost, to construct the power house some distance from the impounding reservoir, and at a lower level, in order to secure a greater pressure at the turbines and utilize a larger proportion of the potential power. Although such a case might be complicated by compensation questions, it would afford some advantages, such as the possibility of taking additional water from neighboring watersheds, and thereby increasing the capacity of the power plant, and the reduction of cost of the machinery due to the greater head of water. The cost of generating power (the load factor remaining the same) varies inversely with the power and the pressure of water.

One very important problem which would arise in connection with water power works is that of providing a market for the power available. In some districts, small towns or villages in the neighborhood of the works could be supplied with electricity in bulk for lighting and power purposes; in other districts, light railways, saw-mills, wood pulping, mines, quarries, chemical and other works might be supplied on mutually advantageous terms; and in the future agriculture should also provide a market for electric power; in fact, there should be few districts in which a market could not be obtained or created.

It is possible that, in the first instance, some opposition might be raised in parliament to the combination of works for the joint supply of water and of power, but in view of the national value of cheap power for industrial purposes and the necessity of conserving coal supplies as much as possible, such opposition might not be great.

The importance attached by parliament to the supply of power after the war can be gathered from the fact that the Board of Trade had recently appointed a committee "to consider and report what steps should be taken, whether by legislation or otherwise, to ensure that there shall be an adequate and economical supply of electric power for all classes of consumers in the United Kingdom, particularly industries which depend upon a cheap supply of power for their development."

The writer has not attempted to deal exhaustively with this subject, but has rather endeavored to bring forward some considerations which appear to him to arise in connection with water power installations, in a form likely to provoke useful discussion.

SALT ROADWAY IN UTAH

Part of the Wendover highway in Tooele county, Utah, is constructed of solid salt. Between Timpie and Wendover the line of the highway traverses a flat area, crossing at one point a salt bed about seven miles wide. For a considerable portion of the year this bed is covered with water, which, while it thoroughly saturates the roadway, is never of sufficient depth to impede the progress of vehicles. When dry, the bed is found to make an admirable pavement, with salt two to three feet deep, hard and smooth.

A bill to empower the president to take possession and control of Niagara Falls power plants, and appropriating $20,000,000 for the purpose, was introduced into the United States Congress January 9th by Representative Waldo of New York.

Canada Foundries and Forgings Company is understood to have had a prosperous year. The company is still operating all its Welland plants to capacity, and in fact did so throughout the year. The Delaney plant in Buffalo, recently purchased by the company, has received additional orders for ship forgings, and the earnings have permitted the retirement already of $100,000 bonds, reducing the outstanding issue to $130,000.

The annual report of City Engineer Brian, Windsor, Ont., shows that during the past year the city has laid 45 miles of paving, 43½ miles of sewers, and 125 miles of cement sidewalks. The paving cost approximately $200,000. Fifteen thousand dollars worth of new sidewalks have been constructed, and two large bridges are almost completed at a total cost of approximately $75,000. This year's sewer construction included the Gladstone Avenue sewer, which has been completed, and the Parent Avenue sewer, furnishing an outlet for the east end of the city, and which will cost approximately $38,000. The Parent Avenue job will not be completed until the coming spring. In addition to these big trunk sewers, smaller ones, namely, the Louis, Catarabui, and Montmorenci, the Grove and Jeannette Avenue sewers have been built, costing approximately $20,000.

RECENT DEVELOPMENTS IN THE DESIGN AND CONSTRUCTION OF ROAD SURFACES*

By H. Eltinge Breed
First Deputy Commissioner, New York State Highway Dept.

Under the new and heavier traffic the old 6-inch waterbound macadam, which for a number of years was thought adequate for all needs, has been cut through and broken up like pie-crust in many sections of the country. Especially has this been true in the spring of the year when the soil conditions are unstable.

The waterbound macadam roads at the war front in France to-day have shown astonishing endurance because they had such splendid foundations. Now they are being built with from 2 to 3 ft. of stone in order to carry the concentrated military traffic.

Everywhere this tendency to increase foundations is obvious; it is essential, because without a good foundation we can have no road that is lasting.

More Complete Drainage

We have noted that the roads broke up owing to heavier loading and unstable soil conditions. It is possible in many instances to make the soil conditions so stable that they will withstand the extra loading placed upon them. This can be done by drainage so placed as to lower the ground water and carry it away from the roadway proper. In flat country large ditches have sometimes been dug over one-half mile long in order to take the water away from the roadway. A number of miles of the Coleman duPont Road in Delaware gives a good example of this kind of construction.

Banking of Curves

This is becoming a more general practice every day. Objections are raised because it encourages people to travel at high speed, but fools will risk their necks anyway and this banking of curves certainly makes the road safer for those driving under strange conditions and lessens the casualties resulting from sharp turns.

Further to obviate the danger of these curves on roads that are 16 ft. in width, in our practice in New York State we have been widening or mooning them out so that in many cases for those of small radius at the centre the actual curve is as much as 24 or 28 ft. wide. This helps by giving an increased range of vision. The banking of the curve gives a further factor of safety because its super-elevation makes steering easier and lessens the likelihood of skidding.

Split Curves

Sight distances could not be procured in some cases where the curve was sharp and dangerous, and then in order that the traffic might be held to its own side of the road, the curve was separated and a parking place with curb was provided.

Approaches to Bridges, to Grade Crossings and at Intersections

Many serious and fatal accidents have been caused by approaches to intersections or grade crossings being on a grade and without proper sight distance. If the grade crossing of a railroad is above the roadway proper it is safer if the roadway be carried out level 25 ft. or more on each side of the track so that it may not be necessary to change gears in driving across. This is also applicable to approaches to bridges which should have a level stretch before passing on to the bridge floor as long as is economically possible to get. This makes easier riding.

Street intersections also should be approached as nearly on the level as possible and greater safety may be secured by cutting the corners to a longer radius. This permits the cars turning sharp corners to keep on their own side of the street until a full turn is made, rather than encroaching upon the opposite side.

Danger Signs

These signs should be visible night and day. To accomplish their purpose and not be in themselves a danger, they should be placed at standard distances from the condition to which they call attention.

There has been a tendency to a more frequent use of guide signs. These should be large and legible enough to be read easily at the average rate of speed. Some States have banded the guard rail and telegraph poles with different colored paints to indicate certain prominent routes. Massachusetts has done this and one can travel practically anywhere in the State without the use of a guide book and without inquiry.

Guard rail, as used, is an unsightly adjunct to a highway. The Interstate Palisades Park Commission has solved this problem from the standpoint of safety as well as esthetics by placing large boulders on edge along the road. This gives as much protection as the guard rail and does not mar the appearance of the work.

Size of Stone Aggregate

There is a general tendency throughout the country to increase the size of the stone aggregate from 1½ to 2½ inches in waterbound macadam, bituminous macadam (penetration method), and concrete pavements. This has the advantage of making a larger amount of the product at the crusher available for use and thereby cheapening the cost of top-course stone. It has the further advantage of giving structural stability to the mass of compacted stone for it may readily be seen that there is greater strength in a uniformly graded aggregate properly fitted together than there can be in single size stone. The use of the larger size aggregate also gives a better surface, because with more stone in the surface and with the use of larger pieces there is less chance for ravelling. Where it is necessary to use softer stone the rolling of consolidation will not fracture or grind up the larger particles as rapidly as it does the smaller ones.

Waterbound Macadam

There have been two methods in use in the past few years in the treatment of this type of road. One has been to form the last puddle with light cold tar or light cold oil. This has the advantage of holding the bond together on the top surface of the road as well as making it dustless. Maryland has some of this class of road and from reports it would seem that it is very satisfactory.

The other method is to treat all waterbound macadams with calcium chloride and a surface treatment of light cold tar or light cold oil, provision for both items being made in the contract. All work that has been properly puddled and bound and subjected to traffic for a period of from 3 to 6 months should be swept clean and the surface application made of bituminous material which is covered lightly with stone chips or coarse sand. This has the advantage of making the pavement dustless and the mat or cushion formed upon the surface prevents it from disintegration and ravelling.

(Continued on page 42, Construction News Section)

*Abstracted from paper read before the Association of State Highway Officials.

ANNUAL MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS

THE annual meeting of the Canadian Society of Civil Engineers will be held in Montreal next week for the fourth time during the war, for the thirty-second time in the history of the society, and probably for the last time under the society's existing name, as the members are now voting to change the name of the society to the Engineering Institute of Canada.

The meeting will be held in the society's building, 176 Mansfield Street, Montreal, and it is expected that it will be fully as well attended as previous annual meetings. The first session will open at 10 o'clock Monday morning, January 21st, with the reading of minutes and the appointment of scrutineers for the election of officers and members of council, for the revision of by-laws and for the vote on the change of name. The remainder of the morning will be taken up by reports of council, library committee, treasurer, finance committee and branches, with adjournment at 1 o'clock.

Opens Next Monday Morning

The afternoon session will be devoted to reports of committees, including those on conservation, roads and pavements, electro-technical commission, steel bridge specifications, education and board of examiners, reinforced concrete, steam boiler specifications, general clauses for specifications and committee on society affairs.

At 7 p.m. an informal dinner, complimentary to visiting members, will be given in the University Club, to be followed at 8.30 p.m. by an entertainment and smoker in the auditorium of the society's building. The committee in charge of this entertainment is as follows:—

J. Duchastel, J. de G. Beaubien, W. D. Black, J. A. de Cew, E. S. Mattice, D. C. Tennant, R. M. Wilson and Julian C. Smith.

The following have consented to act as a reception and introduction committee throughout the annual meeting:—

William McNab, H. V. Brayley, J. A. Burnett, C. R. Coutlee, G. A. McCarthy, F. B. Brown, G. G. Gale, George Hogarth and Aurelian Boyer.

Address on Fuels

At 10 o'clock Tuesday morning the members will meet again to continue to receive reports of committees and to act thereon, should this business not have been completed the previous afternoon. At 10.30 a.m., B. F. Haanal, B.Sc., of Ottawa, will deliver an address on "Fuels." This paper will outline the present fuel situation and discuss the future supply. It is expected that C. A. Magrath, fuel controller of Canada, will be present to take part in the discussion, also R. A. Ross and Arthur Surveyer, members of the honorary advisory council for scientific and industrial research.

The retiring president, Col. J. S. Dennis, will deliver an address at 3 p.m. Tuesday, preceding the unveiling of the honor roll. It is intended to make this unveiling one of the main features of the annual meeting. Major-General Mewburn, minister of militia, and delegates from several other technical societies, have been invited to be present and to speak.

A theatre party, complimentary to visiting members, will be held Tuesday evening.

The reports of the scrutineers will be brought in at 10 a.m. Wednesday, following which the newly elected president will take the chair preparatory to the transaction of new and unfinished business. A meeting of the new council for 1918 will be held Wednesday afternoon.

In previous years arrangements have been made with the Eastern Canadian Passengers' Association, whereby members and their families who paid a full one-way fare to Montreal were returned free of charge on presentation of a standard convention certificate, but it is not certain whether similar arrangements can be secured this year owing to war conditions.

The President-Elect

At this annual meeting, Col. John Stoughton Dennis, C.E., D.L.S., D.T.S., assistant to the president of the Canadian Pacific Railway Company, will be succeeded as

Henry Hague Vaughan, President-elect of the Canadian Society of Civil Engineers

president of the society by Henry Hague Vaughan, vice-president and general manager of the Dominion Bridge Co., Limited.

Mr. Vaughan was a member of the council of the society in 1910 and 1911, and was vice-president in 1912, 1913 and 1914. He joined the society as a member on October 11th, 1906.

He was vice-president of the American Society of Mechanical Engineers from 1910 to 1912, and president of the American Railway Master Mechanics' Association in 1908. He is a past president of the Montreal Engineers' Club and of the Canadian Railway Club, and is a member of the Institute of Mechanical Engineers.

Mr. Vaughan was born in Forest Hill, England, December 28th, 1868, and was educated at Forest House School and King's College, London. Before going to the United States in 1891, he had some experience in railway shop work in England. He was with the Great Northern Railway until 1898, when he became mechanical engineer of the Q. and C. Co. and of the Railway Supply Co., of

Chicago. In 1899 he was appointed assistant superintendent of shops for these companies. In 1902 Mr. Vaughan became assistant superintendent of motive power of the Lake Shore and Michigan Southern Railway, Cleveland, Ohio, resigning in 1904 to accept a position with the Canadian Pacific Railway as superintendent of motive power for eastern lines. He was appointed assistant to the vice-president in 1905, and resigned this position in 1915 to accept the presidency of the Montreal Ammunition Company, which office he still retains. Mr. Vaughan is also vice-president and manager of the Dominion Copper Products Co., vice-president of the Albany Car Wheel Co., and is a member of the board of directors of the Dominion Bridge Co.

Nominees for Vice-President

Two vice-presidents are to be elected this year. The nominations are: H. E. T. Haultain, professor of mining, University of Toronto; R. F. Hayward, chief engineer and general manager of the Western Canada Power Co., Vancouver; and J. G. G. Kerry, of Kerry & Chace, Limited, consulting engineers, Toronto. The late Prof. C. H. McLeod had also been nominated for the vice-presidency.

The Council

Two members to be elected to the council to represent Montreal and vicinity (District No. 1), and one member from each of the other districts. The nominations are as follows:—

District No. 1—C. F. Bristol, construction engineer, Armstrong-Whitworth of Canada, Limited, Montreal; Ernest Brown, professor of applied mechanics and hydraulics, McGill University; J. M. Robertson, consulting engineer, Montreal; Olivier O. Lefebvre, chief engineer, Quebec Streams Commission.

District No. 2—Alex. Duff, engineer of bridges, Canadian Government Railways, Moncton, N.B.; Donald H. McDougall, general manager, Dominion Iron and Steel Co., Limited, Sydney, N.S.

District No. 3—Noel E. Brooks, maintenance-of-way engineer, C.P.R., Sherbrooke, P.Q.; Hon. G. R. Smith, vice-president and general manager, Bell Asbestos Mines, Thetford Mines, P.Q.

District No. 4—John Murphy, electrical engineer of the Department of Railways and Canals, Ottawa; Alex. Gray, mining engineer, Ottawa.

District No. 5—L. M. Arkley, assistant professor of mechanical engineering, Toronto University; Peter Gillespie, professor of applied mechanics, University of Toronto.

District No. 6—G. D. Mackie, engineering-commissioner, Moose Jaw, Sask.; L. A. Thornton, city commissioner, Regina.

District No. 7—A. E. Foreman, assistant city engineer, Victoria, B.C.; E. G. Matheson, professor at McGill University College, Vancouver.

A Solemn Meeting

The annual meeting of the society this year promises to be more solemn than many of the past meetings. The loss of so many members at the front will be brought home to the members more forcibly by the unveiling of the honor roll and the speeches in that connection, and also by the speeches which will no doubt be made in testimonial of the services of the late Prof. Clement Henry McLeod, who was for twenty-five years secretary of the society.

Prof. McLeod died Wednesday afternoon, December 26th, while in his office at McGill University. He had been ill about six weeks before but had made a rapid recovery, and appeared to be in good health just before his death. Prof McLeod was 66 years of ago. He was one of the charter members of the society, having joined as a member on January 20th, 1887. He succeeded the late H. T. Bovey as secretary in 1891, and occupied that position continuously until February, 1917.

Death of Former Secretary

In his death the society loses one of its most energetic organizers and the public, a scientist who has accomplished considerable valuable research work. Born at Strathlorn, Cape Breton, N.S., Prof. McLeod graduated from the Truro High School and in 1873 from McGill University. Following his graduation he was engaged in railway work in Newfoundland and in the maritime provinces, being called to McGill as a professor in 1888.

He was professor of geodesy and surveying and since 1908 had been vice-dean of the engineering faculty. He held the degree of Master of Engineering, was a Fellow of McGill, a life member of the Royal Astronomical Institute and a Fellow of the Royal Society of Canada. Recognized as an authority upon astronomy and surveying, many of his writings have been widely used as texts in advanced scientific courses. One of his achievements was to fix definitely the longitude of Montreal. He was often called by the legal profession as an expert witness on engineering questions as well as regarding his records as to weather conditions.

Prof. McLeod organized his department at the University with great ability. He conducted, in addition to the work at the University itself, a summer school in surveying which has probably not been surpassed by any other on the continent. His ability as an organizer was frequently made use of by the University in the management of public functions and entertainments.

At one time a leading member of the McGill football team, Prof. McLeod was an enthusiastic supporter of athletics in the University. He was chairman of the Grounds and Athletics Committee for many years and was also a member of the Intercollegiate Athletic Governing Board.

Was Noted in Astronomical Work

The observatory at McGill University adjoined Prof. McLeod's residence, and he spent a great deal of time there during the evening, and frequently until a very late hour of the night. He was more than once offered the position of chief astronomer of the Dominion, but he refused to leave McGill. He was the official time-keeper for the Grand Trunk Railway until a year ago when the time-keeping systems of the G.T.P. and G.T.R. were merged.

Prof. McLeod is survived by his widow, four sons and two daughters. The sons are, Norman M. McLeod, contractor, of Toronto; C. K. McLeod, of Nobel, Ont.; W. M. McLeod, a fifth year medical student at McGill University, and Lieut. G. D. McLeod, of the Royal Flying Corps, at present in England. The daughters are Mrs. G. S. Raphael, of Vancouver, and Mrs. (Dr.) R. E. Powell, of Westmount.

The funeral was held from the late residence, the services being conducted by Rev. I. A. Montgomery, pastor of Knox Church. Dr. Symonds, vicar of Christ Church Cathedral, Montreal, a very old friend of the family, delivered an eloquent address on the life of the deceased. The services were attended by a number of representatives of McGill, Toronto and Queen's Universities, and of the Canadian Society of Civil Engineers and other scientific bodies. Interment was in Mount Royal Cemetery.

DESIGN OF RESTRAINED BEAMS CARRYING HYDROSTATIC LOAD

By E. H. Darling, M.E., A.M.Can.Soc.C.E.

THE conditions are sometimes met with in construction, as for example, in rectangular tanks, where a vertical wall must be designed to sustain hydrostatic pressure on one side. If the wall is to be made of steel or reinforced concrete it is necessary to know something of the probable stresses which will be developed and also the effect of stays, ties, or other supports which it may be convenient to provide. There is very little information on this subject to be found in engineering handbooks and a theoretical analysis is tedious work. The accompanying diagrams give coefficients for bending moments, reactions and shears for eight simple conditions, and these may serve as guides in approximating more complicated arrangements.

Hydrostatic Load
Same for all cases.

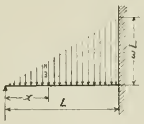


Fig. 9

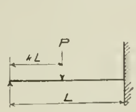


Fig. 10

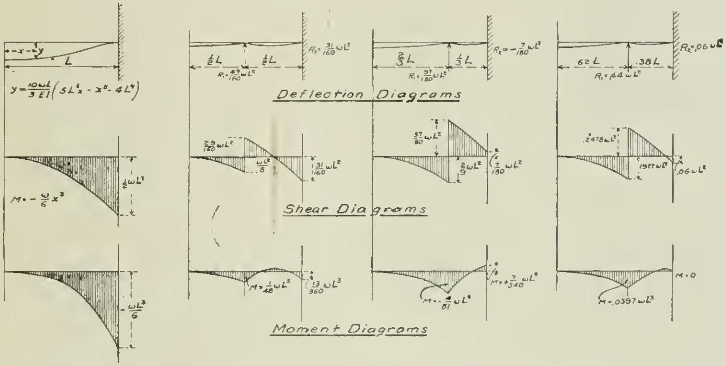


Fig. 1 Cantilever   Fig. 2   Fig. 3   Fig. 4
— One Intermediate Support —

Reaction, Shear and Moment Coefficients for Beam Fixed at One End and Supported at Various Points

L = length of beam in feet.
w = weight of fluid per cubic foot.

It will be noted that we are dealing with a special case of a continuous or restrained beam carrying a uniformly varying load. Any movement of the supports, which are here the ties or stays, will seriously alter the stresses in the beam. Consequently, in actual practice, ample allowance must be made for possible movement. Not only should a large factor of safety be used for the beam but ties and struts, especially long ones, should be designed for low unit stresses so as to minimize the elongation or contraction. In very special cases a more accurate approximation could be obtained by first making a preliminary design, using these coefficients, and then going through the theoretical analysis, allowing for the calculated movement of the supports.

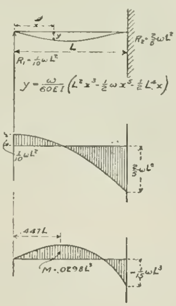


Fig. 5
End Supported

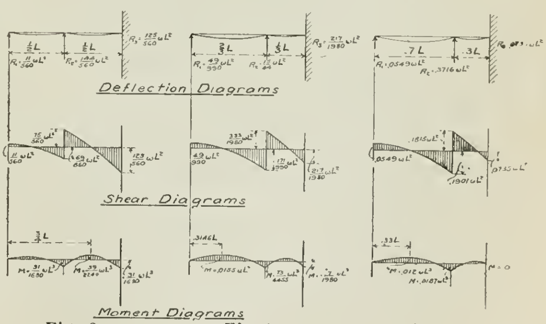


Fig. 6   Fig. 7   Fig. 8
— Two Supports —

Another assumption that has been made is that the moment of inertia of the wall is the same for all horizontal sections. Where this is not the case these coefficients would not apply. It would be necessary to first obtain the correct equation for the elastic curve and use it in the mathematical analysis, or else resort to a graphical method.

These diagrams might also be found useful in the design of bins, caissons, retaining walls, etc., where there may be opportunities for the use of ties or other supports. The pressure exerted by granular material is approximated by substituting an equivalent fluid pressure. The weight of the fluid per cubic foot may be found by the formula

$$w = \tan^2 \frac{90 - \text{angle of repose}}{2} \text{ weight per cubic foot.}$$

The following table gives the weight per cubic foot of the equivalent fluid for a few granular materials, but these values should only be used where the width of the bin is great enough to insure that there is no arching effect such as is found in deep grain bins.

	Wt. per cu. ft.	Angle of Repose.	Wt. per cu. ft. equivalent fluid.
Earth	100 lbs.	45 degs.	17 lbs.
Sand	100 lbs.	34 degs.	28 lbs.
Anthracite	56 lbs.	27 degs.	21 lbs.
Bitu. coal	52 lbs.	35 degs.	14 lbs.
Wheat	50 lbs.	28 degs.	18 lbs.

As intimated above, the mathematical analysis is merely that given in the text books for the solution of problems in restrained beams, of which this is a special case, and is more tedious than difficult. The following examples will illustrate the method:—

1. Beam supported at the one end and fixed at the other.—Let L be the length in feet of a beam one foot wide, fixed at the right-hand end and supported at the other (Fig. 9), carrying a uniformly varying hydrostatic load which equals wx at any point, x, where w equals the weight per cubic

foot of the fluid. Let R_1 and R_2 be the reactions at the supports. Then the equation for the elastic curve, where y is the deflection, is

$$EI \frac{d^2y}{dx^2} = \text{moment at } x = R_1 x - \frac{1}{6} wx^3 \qquad (1)$$

Integrating twice

$$EI \frac{dy}{dx} = \frac{1}{2} R_1 x^2 - \frac{1}{24} wx^4 + C_1 \quad - \; - \; - \qquad (2)$$

$$EIy = \frac{1}{6} R_1 x^3 - \frac{1}{120} wx^5 + C_1 x + C_2 \quad - \qquad (3)$$

The value of C_1 is found from the condition that the tangent of the elastic curve, $\frac{dx}{dy}$ in equation (2), equals zero when x equals L. Also, in (3) $y = 0$ when $x = 0$, therefore, $C_2 = 0$ and the equation becomes

$$y = \frac{1}{EI}\left(\frac{1}{6} R_1 x^3 - \frac{1}{120} wx^5 - \frac{1}{2} R_1 L^2 x + \frac{1}{24} wL^4 x\right) \qquad (4)$$

When $x = L$, $y = 0$, and we obtain

$$R_1 = \frac{1}{10} wL^2 \text{ and } \quad - \; - \; - \; - \; - \qquad (5)$$

$$R_2 = \frac{2}{5} wL^2 \quad - \; - \; - \; - \; - \; - \qquad (6)$$

and substituting these in (4)

$$y = \frac{w}{60\,EI}\left(L^2 x^3 - \frac{1}{2} wx^5 - \frac{1}{2} L^4 x\right) \; - \qquad (7)$$

By employing the proper expression for the bending moment in (1) the solution for any position of the left support can be obtained in the same way. The reactions once found, the bending moments are easily calculated.

2. For two supports.—A solution may be obtained in a similar way, there being two elastic curves having a common tangent and zero deflection at the intermediate support. The following is a less tedious method:—

For a single concentrated load P on a beam, restrained as before (Fig. 10), the deflection under the load is found from text books to be

$$y = \frac{PK^2L^3}{EI}\left(\frac{1}{12} K^4 - \frac{1}{2} K^2 + \frac{2}{3} K - \frac{1}{4}\right) - \qquad (8)$$

and the reaction

$$R_1 = \frac{1}{2} P\,(2 - 3\,K + K^3) \quad - \; - \; - \qquad (9)$$

$$R_2 = \frac{1}{2} P\,(3\,K - K^3) \quad - \; - \; - \; - \qquad (10)$$

If, then, kL gives the location of the proposed intermediate support, find the deflection of the beam at this point under the hydrostatic load by means of equation (7) and also for a concentrated load P by equation (8). Equating these two expressions will give a value for P in terms of w and L and the reactions for this load can be found from (9) and (10). The value of P will be the reaction at the intermediate support for the hydrostatic load and the end reactions are obtained by deducting the reactions of P from those found by equations (5) and (6).

The diagrams, which have all been drawn to the same scale, bring out some interesting points. They show at a glance the relative economy in the use of supports, provided that the saving made in the wall is not more than offset by the cost of the supports. By supporting the top of a wall or side of a tank the bending moment in the wall may be reduced 60 per cent. (compare Figs. 1 and 5).

Assuming the horizontal section of the wall has the same moment of inertia throughout, the most economical position for the support would be a little above the centre as this gives minimum and equal bending moments at the base and support.

With the support at the lower third point (Fig. 3), which is the centre of gravity of the hydrostatic pressure, instead of this giving a reaction at the support equal to the pressure and zero shear and moment at the base, as we would expect from the theory of rigid dynamics, we have a reaction at the support greater than the total pressure and a positive shear at the base. This, of course, is due to the fact that the right-hand is fixed and does not yield so as to allow the load to balance itself over the support.

With the support at a point about $.38L$ above the base we obtain a condition of zero moment at the base. In some practical cases it is very desirable to eliminate bending at this point, where the sides of a tank join the bottom.

When two supports are used one of which is at the top, the most economical location for the intermediate one is at the centre (Fig. 6).

For the condition of zero moment at the base the intermediate support must be placed about $.3L$ above the base (Fig. 8).

TO CONSERVE ELECTRICAL ENERGY

Sir Adam Beck, chairman of the Ontario Hydro-Electric Power Commission, announced recently a scheme that means the saving of at least 50,000 horse-power urgently needed by industries engaged in the production of war materials. This announcement was the sequel to an order issued by Sir Henry Drayton, power controller for Canada.

The following letter has been addressed by Sir Adam Beck to the hydro municipalities and the people using hydro power:—

"The Hydro-Electric Power Commission again bring to your attention the absolute necessity of conserving the use of electric power at all times, and to the fullest extent. There is a great shortage of power for the manufacture of the most important and essential war munitions used in the manufacture of high-grade steel for shells and guns, and also explosives, as well as many other important war materials.

"The Commission, therefore, orders and directs that all municipalities, commissions, companies or persons being supplied by the Commission, exercise the strictest economy in the use of electrical energy, and that, on and after January 15th, 1918, and until further notice, the use of electrical energy for advertising or ornamental lighting shall be discontinued entirely, and that electric street lighting be reduced to the utmost possible limit, discontinuing cluster lighting entirely, and only using such lamps as are actually necessary for the safety of the public.

"Under the heading of advertising is included the interiors of buildings during the hours when the latter are not open for business. Turn off every lamp, switch off every heater and motor, the use of which is not absolutely needed."

Export of power to the United States will not be affected, it is understood, as the Dominion power controller is not concerned so much with exports as with the domestic situation.

The Winnipeg board of control have been warned that the foundation of the Cornish bath and library is slowly giving way and the walls of the building cracking. The city engineer and the building inspector have been instructed to make a thorough investigation, and an early report to the board on the necessary repairs to prevent any further damage to the building.

ICE DIVERSION, HYDRAULIC MODELS AND HYDRAULIC SIMILARITY*

By Benjamin F. Groat, M.Am.Soc.C.E.

THIS paper treats of a new method of diverting surface water and all floating materials carried thereby for the purpose of preventing jams in canals and rivers. The paper also shows how hydraulic works may be designed by studying the performance of small-scale models.

On many of our northern rivers, notably the Niagara and St. Lawrence, there is an immense annual crop of ice which must be taken care of in one way or another in order to protect the various interests along the shores against damages resulting from shoves, jams, and heavy runs.

These heavy floes consist of ice in all its forms and conditions, so that no one method of treatment is likely to be entirely effective against all of them. There is, however, one property, more or less pronounced, which is common to all forms, and this fact is available toward a general solution of the problem. Ice is buoyant unless weighted down by heavier solids, such as stones, frequently carried by the anchor form. Even when no heavier solids are carried, there are forms of such spongy character that the water contained by the interstices produces a water-logged variety, which, once submerged, rises to the surface very slowly.

Some years ago it occurred to the writer that the proper way to divert floating materials is to make the surface currents carry them away, rather than use a boom, which, in reality, opposes, instead of assists, the movement of floatage, and has little or no effect at all on materials suspended below the surface of the water. Following this line of thought, a patent has been applied for which covers both method and means for effecting a diversion of floating materials superficially, and a diversion of water sub-superficially, so that all, or nearly all, the water containing ice can be diverted in one direction,

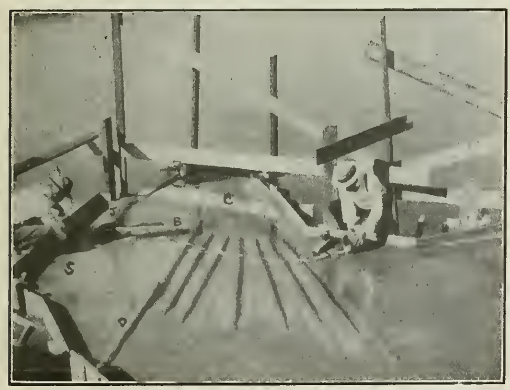


Fig. No. 1.—Model of River; Scale, 1 ft. = 100 ft.

while the remainder can be turned into another—as into a power canal—practically free from ice and all other floating débris. In addition, it is possible to prevent jams and to control the surface currents of a river or stream so that it will be capable of carrying off all floating materials as fast as they are supplied from above, or can form within it.

As it is principally the surface currents which carry floating materials, it will be possible to measure, more or less exactly, the transporting capacity of a river at a particular place by means of the product of the witdh and mean surface velocity at the place. For brevity, this pro-

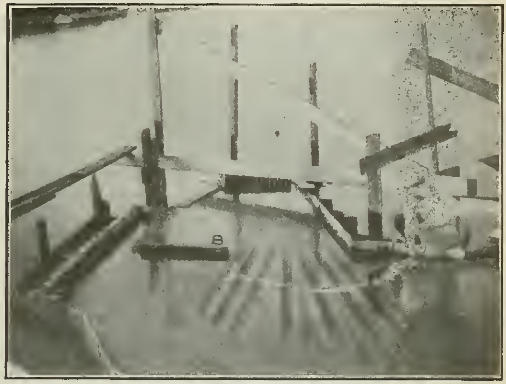


Fig. No. 2.—River Model After Removal of Jetty

duct may be called the "transportivity" of the river at the given place.

The transportivity of a river, then, furnishes a test of the probability of a jam or congestion of ice at any place. If it be found, for example, that the transportivity of a stream, relative to the number of square feet of floatage per second to be discharged, is great at one point and small at another a short distance below, it would appear likely that a jam might form at some intermediate place. Such a condition would exist in a reach of a river which consists of a wide, deep pool fed by a broad, shallow section and discharged by a narrow, deep outlet of relatively large sectional area. Evidently, the pool might be supplied with floating materials more rapidly than it could discharge them, the transportivity of the feeder being much greater than that of the outlet, saying nothing of any ice which might originate in the pool itself.

The foregoing statement is not based merely on theory, but rests on firmly-established facts connected with the winter conditions obtaining on our northern streams generally.

The method, then, by which a diversion of water from a river to a power canal can be made, while all the ice is carried away by the river or main stream, is to cause the river to have a high surface transporting capacity in the vicinity of the canal intake and at the same time reduce to small proportions, or even make negative, the transportivity of the canal intake itself. It is clear that no material increase in its likelihood to jam below the intake will result by reason of this arrangement.

Fig. 1 shows the writer's method and means for securing this important result. A model of an actual river has been constructed to a scale of one-hundredth the full size. This reach is marked *SS'*, and shows the water flowing from right to left. The ice, represented by cakes of paraffin cut to scale, flows with the surface water. The intake of the canal is shown at *C*. In this particular instance, the entrance, or intake, of the canal, is too wide,

*From paper presented to the American Society of Civil Engineers, 1917.

and the first step toward reducing the transportivity of the intake is to introduce a jetty, *B*, extending part way across the opening. The transportivity of the intake may now be further reduced by dredging, or otherwise excavating, several channels in a transverse, or oblique, direction across the main stream and leading toward, to, or even into, the intake of the canal. As the channels must be separated by ridges, or other elevations, between them, the transportivity of the main stream will not be

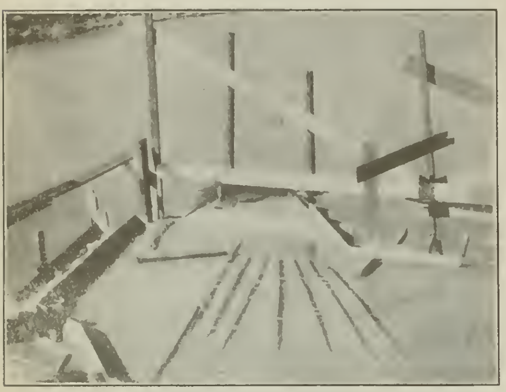


Fig. No. 3.—How Intake Performs When Ice Is Scattered All Over River

altered materially if the crests of the ridges are left at the original surface of the bed of the stream. This condition must maintain because the effective transverse cross-section of the main stream has not been altered materially, though the effective transverse cross-section of the intake has been enlarged to any desired extent. If it should be required to increase the transportivity of the main stream, the ridges may be built to any desired elevation higher than the original bed. This joint control of the surface transporting capacities of stream and canal intake can be exercised by adjusting proportions *ad libitum*.

In many cases it will be found necessary to provide a wing, *W*, to prevent materials from floating into the intake around the up-stream head, and it may be of advantage to construct a jetty, *D*, extending from the shore opposite the intake, or to build some other kind of structure for the purpose of narrowing the main stream in the vicinity of the intake, the object being to concentrate the surface water of the river over the diversion channels or ridges, thus reducing the length of the channels, and, consequently, also the excavation and ridge construction.

It may be further explained that so many transverse channels and ridges will not always be required, though the locations and dimensions of the jetties, wings, channels, ridges, or other elements for effecting a separation of the ice and canal water, must be determined in each particular instance by careful theoretical study most effectively aided by digesting the results of tests on models. As an illustration of such a change from the conditions shown in Fig. 1, the writer may refer to Fig. 2, wherein the jetty, *D*, has been removed. The illustration shows the result of a test with the same hydraulic conditions as in Fig. 1, the ice diversion being nearly as satisfactory, but the wing, *W*, requires considerably more extension into the channel of the main stream. This would be objectionable if navigation would be seriously impaired thereby.

The writer has a theory for the design, construction and operation of such an ice and water separating and diverting works, but will not enter into many details for the present, as it would tend to distract the technical reader's attention from the main principles and facts established, and might be subject to some criticism by persons less accustomed to formal methods of thought and research. However, it may be permissible to explain briefly the operation of the sub-surface diversion channels and ridges.

It is evident that water must flow from the main stream to the divergent canal if there is any draft by consumers along the canal. This will cause a greater or less tendency for all parts of the water in the main channel and diversion channels to flow toward the canal, as the water consumed or otherwise taken from the latter would naturally cause a fall of the water surface at the intake within the canal, and this would leave a surplus head or pressure of water at all parts in the main stream and diversion channels toward the intake.

The water in the main current, however, is flowing rapidly down the main channel because of the restricted cross-section in that direction, and the water in the transverse diversion channels is not, as it can have no component motion of any consequence at right angles to the direction of the adjacent ridges. The water in the trans verse oblique channels, between the ridges and below their crests, can flow with facility only in the direction of, or toward, the intake of the divergent canal, which it does.

Not so with the water at or near the surface of the main stream at places which are not below the crests of the ridges. This water does tend to move toward the intake, but only by reason of divergent or transverse accelerations which cause the main currents above the ridges to become more or less curved and concave toward the intake.

If the widths of the main stream and intake, the elevations of the crests of the ridges, the depths of the transverse channels, and the geographical configuration of earth and water in the vicinity of the intake have re-

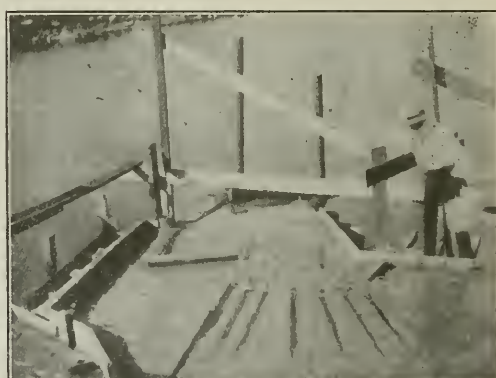


Fig. No. 4.—Showing Effect of Plugging the Downstream Ends of the Diversion Channels

ceived proper attention with a view to design, alteration, construction, and operation, the surface currents of the main stream will not be impelled toward the intake sufficiently to cause any of the water at the surface to move into the intake and down the canal while it is at the surface.

It is a fact that the writer's method and invention put the forces indicated by this theory into actual operation and furnish a means for constructing and operating the intake of the canal and main channel in the vicinity of the intake, so that no surface water, and, therefore, no floatage, will enter the canal from the main stream. With sufficient intelligent application of the theory, the surface transportivity of the intake can actually be made negative, so that the surface of the water will flow outwardly therefrom into the main stream, the canal receiving a sufficient supply of water from the sub-surface or lower portions of the main stream to take care of the combined requirements of the canal and negative currents.

This effect can be produced with more or less intensity by making what may be called a sub-surface diversion of water to the canal from the lower portions of the main stream in greater quantity than would be necessary simply to supply the water required for the canal. The result of this is that the excess water diverted sub-superficially must cause a counter or compensating current flowing outwardly from the intake into the main stream.

Fig. 3 shows how the intake performs when ice is scattered all over the river. It may be remarked that the density of paraffin is only a trifle less than that of the heaviest ice, and about the same as that of the lightest. When the cakes of paraffin have been used for a time they become covered with particles of dirt and grains of sand adhering to the faces, which have the effect of increasing their weight. It will be observed that no paraffin, and, therefore, no ice, enters the canal.

Fig. 4 shows the effect of plugging the down-stream ends of the diversion channels. Nearly all ice passing near the wing enters the canal, but it will be noticed that ice which chances to be over the unobstructed parts of the channels is not drawn into the canal, but passes on down the main stream, away from the intake, beyond the influence of the canal draft. This is all clearly shown in the figure.

Fig. 5 shows the result obtained when the channels are completely obstructed by filling them with clay to the

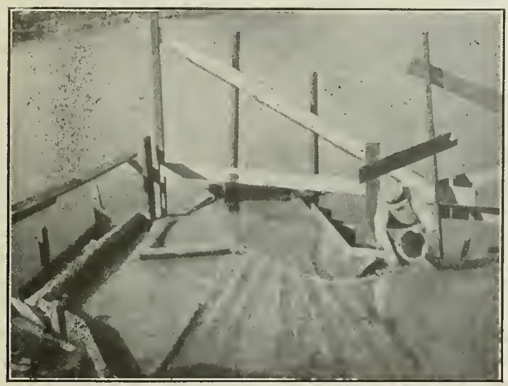


Fig. No. 5.—Channels Completely Obstructed

original elevation of the bed of the river. Here all the ice placed in the river at the wing passes into the canal.

Fig. 6 shows the operation of the intake in its natural condition, without diversion channels, ridges or wings. The outlines of the diversion channels show in the illustration, because the clay with which they are filled differs in color from the sawdust concrete out of which the bed of the river was constructed. A large proportion of river ice—more than half on the average—enters the canal.

Performance of Models

The writer has experimented with small-scale hydraulic models several times. His conclusion concerning this matter is that models perform in much the same way as the full-size prototype. In fact, there was nothing in the results of the experiments to indicate that they did

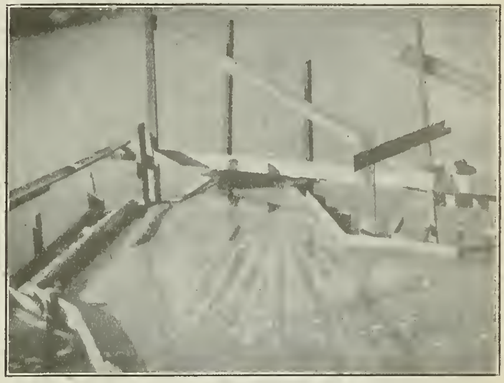


Fig. No. 6.—Showing Operation of the Intake in Its Natural Condition

not perform exactly as their prototypes. These statements apply equally to hydraulic models of all kinds, whether they be of machines, such as water-wheels and pumps; of structures, such as overflow dams, weirs and spillways; of sections of an actual river or canal, or of ships.

If, for example, a model of a section of a river has been constructed of sufficient size to prevent undue influences from properties of the fluid and materials which do not change by proper amounts with a change of scale, for example, viscosity, surface tension, etc., it will be found that the model performs almost exactly as the real section of river. Velocities, direction of flow, slopes of water surfaces, configuration of eddies and bends, are all repeated in the model with great fidelity, supposing, of course, that the model has been accurately constructed and that we understand what is meant by mechanical similarity, as well as by geometrical similarity.

In the case of hydraulic models, it can be shown that homologous velocities in models of different size must be proportional to the square roots of homologous linear dimensions. When the quantities of water have been properly adjusted to comply with this requisite, it may be said that the mechanical and hydraulic conditions in the two models are mechanically and hydraulically similar, just as the configurations of fluids and solids in the models are geometrically similar.

This requirement of mechanical and hydraulic similarity has certainly been overlooked in some of the most important tests of models. Its neglect has led to the belief among many that models cannot be relied on except as a means leading to rough approximations of doubtful value. Perhaps the tests of model water-wheels afford the most striking example. So far as the writer is aware, little heed has been taken to see that model water-wheels are tested under the proper heads; or, what is the same thing, if the head is fixed, as at Holyoke, that the size of the model wheel is properly proportioned to the head.

This is saying nothing at all of the setting of the model water-wheel, which frequently bears no resemblance to the full-size setting.

Suppose, for example, that a water-wheel 110 in. in diameter is to be erected on a waterfall of 180 ft. If the test is to be of a model operated under 16.5 ft. fall, then the diameter of the model should be only about 10 in., as the head for the model is only about the eleventh part of the total fall of water at the waterfall. In short, the actual fall and that in the model must be in the same ratio as the linear dimensions of the homologous parts of the water-wheel and its model. It is this important requirement which is frequently lost sight of. As wheels of 30 in. or more are usually tested, it can be easily inferred that a test on such a size would result in too high a value for the efficiency in the case cited.

If the surfaces of the water passages in the model are made sufficiently smooth to represent correctly the homologous parts of the actual passages, the actual wheel and its model should perform alike. It can be shown that this simply imposes the condition that the resistances to the flow of water over the homologous areas vary jointly as the homologous areas and the squares of the homologous velocities. This, we know, is nearly realized in practice. It follows that the foregoing statements are substantially correct.

The fact that homologous velocities must be proportional to the square roots of homologous linear dimensions is a fortunate matter, when the model is to be on a very small scale. Otherwise, the velocities in the model might be so small that they would not exceed Reynold's critical velocity, and thus the requirement of mechanical similarity would not be realized.

PRESENT STATUS OF GRANITE BLOCK PAVEMENTS*

By Clarence D. Pollock
Consulting Engineer, New York City

THE early specifications for granite blocks called for blocks of about the following dimensions: Length, 8 to 12 inches; width, 3½ to 4½ inches, and depth of 7 to 8 inches. These were paved upon a sand bed spread upon the earth sub-grade and the joints were filled with sand.

The next step was to use a concrete foundation under the sand cushion and a joint filler of gravel poured with bituminous material. The maximum width of joints was usually ¾ inch. The pavement was rammed and back-rammed, after which an attempt was made to scratch out the gravel from the top portion of the joints, and then the bituminous material was poured in while hot. This was unsatisfactory, as the filler simply matted on the top of the gravel unless the conditions were almost ideal. The next change was to put a small amount of gravel in the joints and then pour this part of the joint, after which dry and hot gravel was added and the joints were given a second pouring. This was an improvement, but as the joints were wide, the blocks chipped on the edges under traffic, and the pavement became rough and uncomfortable to ride on.

These blocks were large, having a depth of from 7 to 8 inches and were often 13 inches and even as much as 14 and 15 inches in length. With such deep blocks it was not practical to cut them so that they would lay with close joints.

Finally, some seven or eight years ago, at a conference between municipal paving engineers and the granite quarrymen, it was agreed to use a smaller and better cut block. This was the beginning of our modern granite block pavement. The present standard block has a width of from 3½ to 4½ inches, a length of 8 inches to 12 inches, and a depth of 4¾ inches to 5¼ inches.

Further requirements are that "the paving blocks shall be of medium grained granite, showing an even distribution of constituent materials, of uniform quality, structure and texture, without seams, scales or disintegration, free from an excess of mica or feldspar. The blocks shall be so dressed that the faces will be approximately rectangular in shape, and the ends and sides sufficiently smooth to permit the blocks to be laid with joints not exceeding ½ inch in width at the top, and for 1 inch downward therefrom, and not exceeding 1 inch in width at any other part of the joint. The top surface of the block shall be so cut that there will be no depressions measuring more than ⅜ of an inch from a straight edge laid in any direction on the top and parallel to the general surface thereof."

The above requirements are in the specifications of the American Society of Municipal Improvements, and are now in very general use. Of course, there are numerous exceptions to these standard blocks. A few cities specify a block with a length of 6 to 10 inches with a top surface or head cut so that there will be no depressions measuring more than ¼ of an inch and to lay to a joint not exceeding ⅜ of an inch. Such a specification may produce a pavement with possibly 10 per cent. of the joints better than with the standard specifications, but as the area of the head of the block is smaller and consequently more blocks are required to the square yard, it adds considerable to the cost of the pavement and the writer is of the opinion that this extra expense is not warranted except in rare instances. When standard blocks are well cut and properly paved under the specifications that the joints shall not exceed ½ of an inch in width, something like 75 per cent. of the joints will comply with the more rigid specification and it would seem unnecessary to spend an additional forty or fifty cents per square yard to have possibly another 10 per cent. of the joints a little closer. Such a requirement is practically as rigid as that for cut stone joints in building construction. It is not a practical proposition to split out paving blocks so that a ⅜ of an inch joint can be rigidly complied with. If a cement grout filler is used, such a joint is not necessary, and it is very questionable if it is ever necessary with even a bituminous filler. It certainly is not desirable to specify something which it is not practicable to obtain.

Other variations from the standard are so-called 4-inch blocks, Durax blocks, and the like. It is sometimes necessary because of freight charges, etc., to use shallow blocks, or else use a pavement which is less durable than granite blocks. This condition is more likely to prevail on road work and in inland cities where there is a rail haul.

Then there is another condition which requires a shallow block, and that is where the traffic conditions have changed so much that it is necessary to use granite to replace a lighter material, and yet it is desired to utilize the old concrete foundation. For such a condition a resurfacing block is made which has a depth of 3½ to 4 inches. It is preferable to lay such a block upon a cement mortar cushion, especially if the traffic is heavy.

The standard block, when properly cut and laid, is the most suitable for general conditions. This pavement is

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*Abstracted from paper read before the Annual Meeting of Section D Engineering of the American Association for the Advancement of Science, Pittsburg, December 28, 1917.

laid in various ways. In cities and localities where it is possible to block off traffic for a sufficient time to permit the use of a cement grout filler it is usually laid with such a filler, and if the traffic is heavy enough to warrant the expense, it is often laid on a cement mortar cushion mixed in the proportion of one part of cement to three or often four parts of sand. This makes a very solid and durable pavement when properly done. The blocks should be sorted and laid in courses so that blocks as nearly as possible of the same width are in a course and the blocks should be paved with close end or longitudinal joints, the courses running transversely from curb to curb. The transverse joints should be as close as possible and yet keep straight courses. The longitudinal joints should be broken by a lap of at least three inches.

The pavement should be thoroughly rammed and all poorly bedded blocks raised and back-rammed until the blocks are all well and evenly bedded and the surface of the pavement is true and even to the grade and crown of the street. It is advisable to use no sand or gravel in the joints. Proper ramming will cause the blocks to sink into the cushion so that a little ridge of the cushion will separate the blocks and be sufficient to hold them until the filler is poured, provided wheeling and other traffic is not permitted over the surface.

Now the pavement is ready for the filler. If it is to be a cement grout filler, it should be mixed in the proportion of one part of Portland cement to one part of fine sand, preferably an even-grained sand, and, when possible to obtain it without excessive cost, one which will pass a 20-mesh sieve. The finer and more even the sand particles, the better they will remain in suspension and make a uniform filler. A machine mixer should be used in order to secure a uniform product and the grout should be delivered directly upon the pavement by means of a chute or spout. The grout should then be broomed into the joints thoroughly until they stand full and flush with the surface of the blocks, but a surplus should not be left over the surface. The wear should come upon the granite. The traffic will then wear down any small irregularities in the heads of the blocks.

When a bituminous filler is used the best practice is to add a fine hot sand and mix it before pouring the joints. A straight coal-tar pitch is too susceptible to temperature changes to be used in this climate, but a mixture of one part of asphalt with five parts of coal-tar pitch gives good results, as does also an asphalt filler. With either of these there should be added not to exceed 50 per cent. by volume of fine sand similar to that used in a cement grout filler. The amount of sand added should be at least 35 per cent. The sand should be mixed into the hot bituminous material and then drawn off into wheelbarrows or the like and dumped at once upon the pavement. It can then be worked into the joints by means of hose or the like. When the joints are thoroughly filled so that they stand up flush with the surface of the blocks, then a small amount of sand should be spread over the surface. This will prevent traffic from sticking and will help to harden the surface of the joint filler.

Brooklyn, N.Y., uses a mixture of coal-tar pitch, 100 parts; refined residual asphalt, 20 parts; to which, after thorough mixing, is added not to exceed one part of sand to one part of this bituminous mixture. The sand is fine, passing a 20-mesh sieve and is stirred in usually by a mechanical mixer.

In the Borough of Manhattan one part of hot asphalt cement is mixed with not to exceed one part of sand, the latter to pass a 10-mesh sieve. The mixture is made in a concrete carrier or pushcart of about seven cubic feet capacity.

The mixing is done with a rake or a perforated hoe. Both here and in Brooklyn the hot bituminous mixture is dumped directly upon the pavement and is pushed into the joints by means of hoes or squeegees.

These forms of bituminous fillers give the best results for this class of filler.

Bituminous fillers are most suitable for use when the traffic conditions are such that it is not practical to block off the street a sufficient time to permit the proper setting of a cement grout filler.

The cushion course on top of the concrete is usually sand and it should not be greater in depth than an average of one inch. This is sufficient with a specification allowing only a maximum variation of ½ inch in the depth of the blocks. Of course, the surface of the concrete should be smooth and it should conform to the crown of the finished pavement.

In some localities a dry mortar cushion of one part cement to four parts of sand has been used with success, especially where the joint filler was cement grout. This makes a very rigid pavement, and where the traffic warrants the additional expenditure of about fifteen cents per square yard it is probably advisable. The mortar cushion has been used also with a bituminous filler, but this seems to the writer to be a useless expense as the traffic is allowed on the pavement before the cushion can obtain a proper set and an examination of many openings has failed to show him a case of a bond between the bottom of the block and the mortar cushion. The claim is made that this cushion does not wash if any water finds its way through the joints of the pavement. If the joint filler is properly placed in the joints there should be no trouble from this course, even with a sand cushion. With a cement grout filler the blocks are held rigidly and the cushion obtains a proper set as the traffic is blocked off in order to permit the grout to set, and the cushion has the same opportunity.

Even with the great strides which have been made in granite block pavements in the past half-dozen years, there are still a great many people in our cities who still picture the old-style rough, open-jointed granite pavements when they hear granite mentioned in connection with pavements. As a matter of fact, these same people will ride over the modern smooth surface granite block pavements laid with cement grouted joints or with the latest form of bituminous joints and not recognize that it is a granite block pavement, and consequently fail to give it the credit which is its due.

The modern granite blocks, when properly laid, make a pavement which is as near permanent as it is possible to lay, and which is smooth and yet not slippery. While it is not wholly noiseless under metal tire traffic, yet because of its smoothness and the fact that the percentage of this kind of traffic is getting smaller and smaller each year, it is rapidly becoming a noiseless pavement.

The great improvement in the surface and the joints of this pavement in recent years has been due wholly to the co-operation between the engineers and the granite quarrymen. They have worked together in the endeavor to produce as good a block as it is practicable to make on a commercial scale, to have these blocks paved better and closer than formerly and to have the joints really filled with more permanent kinds of joint fillers. Neither the engineers nor the quarrymen could have accomplished this alone, but both working together with the same goal in mind resulted in great improvements in granite block pavements in a comparatively short time.

THE EFFECT ON ORIFICE AND WEIR FLOW OF SLIGHT ROUNDINGS OF THE UP-STREAM EDGE*

By Jacob O. Jones

THE effect on weir flow of the upstream vertical curvature has been investigated by Messrs. Fteley and Stearns, the results being reported in Vol. 12 of the Trans., Am. Soc. C.E., pages 97-101. Also Mr. G. Wells Ely and Mr. Francis M. Dawson, each investigated this problem for his graduate thesis. Ely's experiments were upon weirs with the upstream corner rounded to a radius of from 1 in. to 36 ins. Dawson experimented with roundings of 1/8 in. to 1 in. Fteley and Stearns investigated the effects upon weirs with crest radii of 1/4 in., 1/2 in. and 1 in. Fig. 1 shows the percentage increase in discharge at 0.4 ft. head due to roundings of from 1/8 in. to 1/2 in., the plotted points being computed from the results of the experiments of Dawson, and Fteley and Stearns.

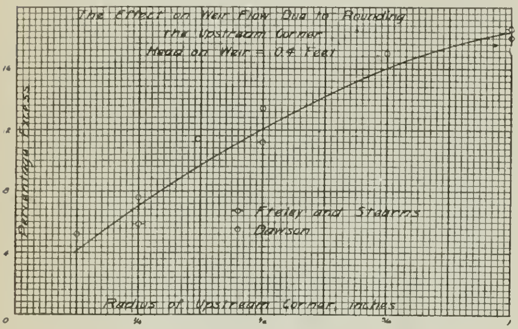

Fig. No. 1.—Curve Showing Increase in Discharge at 0.4 ft. Head Due to Roundings of 1/8 to 1/2 in.

It was the desire to determine the location of this curve from the 1/8-in. radius down to a sharp-edged weir, that constituted the second reason for this investigation.

Description of Apparatus for Weir Experiments

The weir experiments were performed with the apparatus which is permanently set up in the Cornell University Hydraulic Laboratory. The weir channel is made of reinforced concrete, is 24 ins. wide, 48 ins. deep and 30.33 ft. long. Water is admitted to the canal from a 10-in. pipe which brings the water from Beebe Lake. Just below the 10-in. gate valve, which controls the supply, is a flaring tube which serves to reduce the velocity somewhat and probably reduces the boiling action of the water. At the connection with the gate valve its cross-section is a 10-in. circle, and in a distance of about 2 ft. it changes to a 16-in. x 20-in. rectangle.

Two feet downstream from the discharge tube is a galvanized iron baffle, which consists of strips of galvanized iron 6 ins. wide placed in a horizontal position and 1/2 in. apart vertically. Another baffle is placed 1 ft. 4 ins. downstream from the first one.

Three feet downstream from the baffles is a "fence." This consists of strips of 1-in. boards nailed to upright pieces and rigidly fastened in the channel. Its purpose is to control the velocity distribution in the channel. It was desired to have as nearly uniform velocity as possible. To that end several fences were tried, velocity measurements being made with the current meter with the several fences successively in place. For the highest head the velocity was greatest near the surface and seemed to be less on the right side than either on the left or in the middle.

The head was measured by the means of float gauges. The floats had fins projecting outward from the sides to render them unsusceptible to the influence of capillarity. They were located 8 ft. upstream from the weir, one on either side of the channel. The still wells were sections of 6-in. wrought iron pipe, and were connected to the channel by 1-in. pipe. The 1-in. pipe entered the channel through the side wall at right angles to the direction of the current, at a point near the bottom, and the inner end of the pipe was flush with the face of the wall.

Over the channel between the float gauges was a current meter gauging station. An upright frame fastened securely, had notches cut to receive the current meter rod, so that the current meter was held vertically and always in the same vertical cross-section of the channel. The verticals designed as middle, left and right, were in mid-channel, 6 ins. from left wall, and 6 ins. from right wall, respectively, looking downstream. The current meter used was a small Price single-point meter.

The weir crest was a brass plate 2 ft. 3/16 in. long, 12 ins. wide and 1/4 in. thick, the top edge of which was machined. This plate was fastened to the wooden bulkhead with eight brass screws, and after being thus securely fastened, the ends were further secured with a neat cement mortar. Great care was taken to make the crest level.

Inasmuch as the investigation had to do with the effect of slight roundings of the upstream corner on the discharge, it was exceedingly important to have a truly square, sharp corner to begin with. Accordingly, after the crest plate was received from the machinist it was carefully dressed with a small fine-grained corborundum stone. At all times care was exercised to protect the edge from blows or any accident which would nick it, and after the sharp-edged series was completed only one very small nick was found.

The bulkhead to which the weir plate was fastened was made of 2-in. tongue and grooved lumber. It was securely fastened with screws and in addition a neat cement filler was placed in the corners where the ends and bottom joined the sides and bottom of the channel. This made it so nearly water-tight that not even a drop of leakage was observed.

The nappe was confined by a prolongation of the sides of the canal which extended down to the level of the bottom of the channel. To provide aeration, strips of tin, concave downward, were fastened to the bulkhead and projected outward through the nappe.

The lower end of the canal terminated in a galvanized sheet iron hood. The lower part of this hood discharged the water into a flexible sheet iron spout, by means of which the stream could be diverted at will in a fraction of a second either into the 70 cu. ft. iron tank No. 2, into the 400 cu. ft. concrete tank or into the waste channel.

Observations and Observing

The work involved the measurement of the following variables: (1) Total quantity of water discharged, (2) the time necessary for the quantity of water to be discharged, (3) the head that prevailed during the time interval above mentioned. In addition to these variable quantities there were several more or less constant quantities to be measured. These were length of weirs, zero readings of all gauges, and the precision of the quantity measuring

*Abstract of article in "The Cornell Civil Engineer."

devices. The standard that the writer set for himself in the beginning was an accuracy of 1 in 1,000.

The length of the weir crest was obtained by the use of two ¼ in. square rods which were arranged to slide upon each other in the manner of inside calipers. They were placed in the canal and adjusted until the points were in contact with the sides of the canal and then removed and the distance between points ascertained with a brass scale graduated to .01 ft. It was necessary to estimate .001 ft., but this can be done with a fair degree of accuracy, and an error of even .002 would mean only 1 in 1,000, inasmuch as the crest was something over 2.00 ft. long.

The zero readings of the float gauges were determined in the following manner: A hook gauge was clamped to the bulkhead, to which the weir plate was attached, by means of an ordinary carpenter's clamp. The point of the hook was carefully brought to the level of the crest by means of a small pocket level and the hook gauge slow-motion screw; one end of the level, which was about 6 ins. long, resting upon the crest and the other end upon the point of the hook. The distance below the crest of the surface of the water in the approach channel was determined by lowering the hook and adjusting the point to coincide with the surface in the usual manner. Simultaneously the readings of the float gauges were observed. By adding the distance (from the surface of the water to the crest level) to the float gauge readings, the zero reading was obtained. In this operation care was exercised to have the surface of the water in the approach channel not more than 0.2 ft. below the level of the crest, and to maintain the surface at a fairly constant level. Because of leakage from the flume it was necessary to keep a small stream of water running into it to equalize the loss. These precautions were necessary to obviate error. In the first case, if the distance moved through by the hook gauge

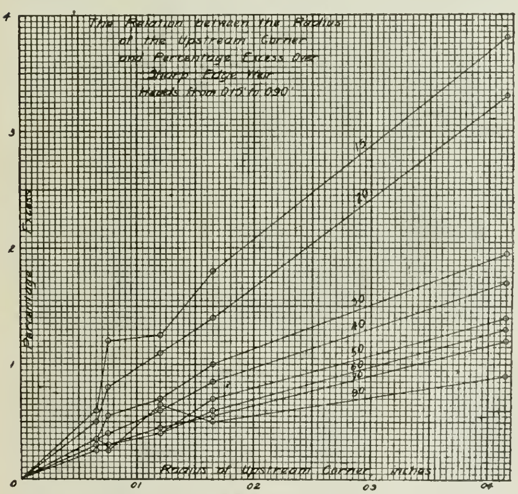

Fig. No. 2.—Relation Between Radius of Upstream Corner and Percentage Excess Over Sharp Edge Weir

from the crest level to the water surface were great, some error might be introduced due to a failure to make the hook gauge plumb. In the second case, if the surface of water should be falling rapidly, unless the readings of the hook gauge and the float gauge were simultaneous an error would be introduced.

The weir discharge measurements were made with iron tank No. 2, and with the 400 cu. ft. concrete tank. In either case the discharge measurements are believed to be accurate to well within 1 in 1,000.

The head observations for the weir experiments were made with the float gauges.

The operating conditions were for the most part very steady. For the weir experiments the flow was steady up

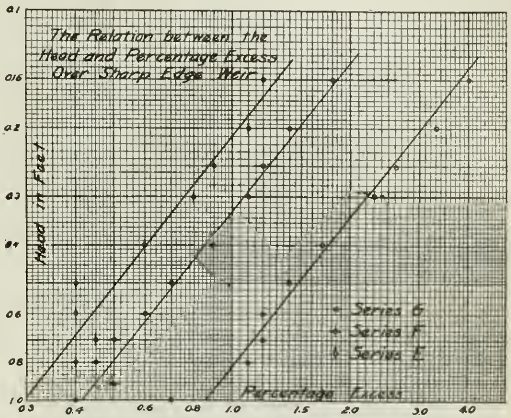

Fig. No. 3.—Relation Between the Head and Percentage Excess Over Sharp Edge Weir

to a head of 0.5 ft. Above this head the following range of gauge readings are representative:—

Mean observed head, in feet.	Range of readings, in feet From	To
0.6015	0.6005	0.6035
0.6981	0.6965	0.7005
0.8003	0.7980	0.8030
0.8979	0.8955	0.9025
1.0010	0.9975	1.0055
1.0985	1.0955	1.1045
1.3542	1.3515	1.3590

A raft of 2-in. x 10-in. plank 5.0 ft. long was placed in the approach channel just below the fence. This served to still the surface and eliminate standing waves. The head gauge was under constant observation during a run in both the orifice and weir experiments, and the mean observed head is the average of a large number of readings.

In the weir experiments the discharge measurements were reduced to cubic feet per second per foot of weir length.

The weir was rounded without removing it from the channel. For series B the edge was rubbed once across, with a piece of fine emery paper tacked on a board, under pressure of two or three pounds. For series C it was gone over twice more. The rounding for series D and E was accomplished in much the same manner except that a pad of felt was tacked on the board and covered with fine emery cloth, the result being that when the weir was rubbed with this, it being somewhat yielding, produced more of a real rounding, rather than an octagonal effect. For series F and G the edge was rubbed across twice with a fine file and then smoothed with the emery pad. For each series care was exercised to rub all parts of the edge

(Concluded on page 42, Construction News Section)

Coal Problem of Canada Demands National Action*

Vital National and International Question—Our Natural Resources Not Inexhaustible—Canada's Present Dependence Upon the United States for Coal—The Dominion Possesses Independent Fuel Resources Which Must Be Developed

By ARTHUR V. WHITE

SO much has been said, drawn from seemingly authoritative sources, respecting the "unbounded extent of the natural resources of Canada," that it is little wonder the popular view is entertained that Canada's resources are practically unlimited, and perpetual prosperity only waits upon their fuller development. For Canadians, however, to hold and be governed by such a view is to live in a "fool's paradise."

Little more than a decade ago, a large majority of the people of the United States believed that the natural resources of their country were unbounded, and that there was hardly any limit to material progress based upon their development. Even in that country, however, there were many who did not share these views, and through their efforts special investigation was made respecting the actual conditions of the natural resources of the nation.

Natural Resources of United States Exhaustible

The President called for a conference of the governors, leading officials and experts of all the States of the Union.

Addressing the conference on the 13th of May, 1908, the President stated:—

> "This nation began with the belief that its landed possessions were illimitable and capable of supporting all the people who might care to make our country their home; but already the limit of unsettled land is in sight, and, indeed, but little land fitted for agriculture now remains unoccupied save what can be reclaimed by irrigation and drainage. . . We began with an unapproachable heritage of forests; more than half of the timber is gone. We began with coal fields more extensive than those of any other nation and with iron ores regarded as inexhaustible, and many experts now declare that the end of both iron and coal is in sight. . . . The enormous stores of minerals, oil and gas are largely gone. . . . Our natural waterways are not gone, but they have been so injured by neglect and by the division of responsibility and utter lack of system in dealing with them that there is less navigation on them now than there was fifty yars ago. Finally, we began with soils of unexampled fertility, and we have so impoverished them by injudicious use and by failing to check erosion that their crop-producing power is diminishing instead of increasing. In a word, we have thoughtlessly, and to a large degree, unnecessarily, diminished the resources upon which not only our prosperity, but the prosperity of our children and our children's children must always depend."

Canada's Natural Resources Also Exhaustible

No country possesses, within its own borders, more varied and extensive resources than the United States, yet it is now recognized that many of these are within measurable distance of exhaustion. This fact was so clearly demonstrated that prompt action by the trustees of the nation became imperative. So far as one can judge, natural resources from the 49th parallel to the Gulf of Mexico are better situated, geographically, and must always be more desirable than those from the 49th parallel to the Arctic ocean; thus, by reason of situation, Canada's usable natural resources are in variety and extent less than those of the United States.

Those who have observed the rapid disappearance of many of the natural resources of Canada and the present alarming rates at which some are being consumed, realize that the situation, as a whole, is one of great gravity. Consequently, true conservation in Canada is as great, if not greater, a necessity than in the United States.

On the 6th of December, 1917, at the annual meeting of the Bank of Montreal, its president, referring in hopeful terms to Canada, said: "Our natural resources are unbounded and our credit is irreproachable."

Now, as a matter of fact, our resources are not unbounded, and our very credit is involved in the use we are making, and shall make of the resources at our disposal. Many of these, as just stated, at present rates of depletion, and without proper methods of conservation being rigidly applied, are within measurable distance of exhaustion. By way of illustration: There was a time—and not so very long ago either—when the buffalo and the carrier pigeon existed in the United States and Canada in countless millions. To-day they are gone.

Resources Must Be Wisely Used and Conserved

It is true that some resources, such as minerals—perhaps more especially coal, oil and gas—if used, must in time, necessarily become exhausted. On the other hand, such resources as the soil, plant growth, waterways and ground waters, may be conserved and transmitted to posterity unimpaired, or at least unabused, just as a good husbandman passes on his farm in an improved condition to that in which he received it. The policies advocated by the Commission of Conservation of Canada have aimed at passing on to succeeding generations in an improved condition the heritage of the natural resources of this country.

By intelligent and thrifty use, the natural resources of Canada may beneficently serve the needs of a large population. If, however, Canadians become really dependent upon necessary commodities supplied them by other countries, they must be prepared to accept the circumstances in which they may suddenly find themselves if the supply of such commodities is cut off. Such circumstances will be aggravated by any abuse of our assets.

Coal Scarcity and Coercion

There is, apart from food, raiment and shelter, perhaps no single commodity which has been found so necessary for the maintenance of life and for the carrying on of commerce and transportation as fuel—chiefly coal. During the past few months the public interest has been keenly aroused respecting the nation's fuel supply and increasing dependence upon hydro-electric energy. The present war conditions are going to drive home to Canadians as never before the tremendous gravity of their position with respect to fuel.

Countries like Norway and Sweden, Denmark, Holland and Switzerland—countries, indeed, which are neutral—are practically dependent upon the warring nations for coal, and have found themselves seriously curtailed in obtaining this commodity. They have been forced to recognize the momentous fact that the countries which possess coal are able, absolutely, to dictate the terms upon which coal will be supplied to others

Norway and Sweden are short of coal. Both Great Britain and Germany have released coal to these countries in exchange for food. Britain has required European neutral ships calling for coal to bring cargoes of foodstuffs or other desirable commodities. Holland must get its coal from Germany, which consents to supply it only in return for large quantities of food, especially vegetables and meat raised on Dutch soil. Holland at present has open to her no other market in which to secure coal. From Switzerland, Germany demands cash at the rate of 40,000,000 francs monthly for nine months at five per cent. in return for a monthly delivery of 200,000 tons of coal; and within the last month it has been reported that Germany has liberated some hundreds of agents instructed to secure control of the hydro-electric resources in Switzerland, so that, with these under their direction, and in control, also, of the coal supply, Germany would more completely dominate Switzerland. One of the chief factors which has existed in connection with Alsace-Lorraine has been that Germany wishes to maintain this outlet for her coal and in return derive from these areas the supply of iron which

*From the "Monetary Times Annual."

she herself lacks. The necessities of life—not the precious metals—are the real arbiters of exchange.

Now, a very large portion of Canada—and for this one may hold in mind much of the populated territory extending, say, from Quebec to Winnipeg—has become increasingly dependent for its fuel supply upon the coal fields of the United States, and absolutely dependent upon that country for its annual supply of some 4,500,000 tons of anthracite coal.

Portion of Canada Dependent Upon United States

In addition to the use of imported anthracite coal for fuel for heating and domestic purposes, large quantities of bituminous coal—some 10,000,000 to 14,000,000 tons—are also imported from the United States, largely for power purposes.

The known anthracite coal fields of the United States are within measurable distance of exhaustion. Upon this point there seems little difference of opinion. The time during which the supply will last, at rates of consumption existent prior to the war, is placed at about one hundred years. Doubtless, in the near future, the United States will feel compelled to conserve this valuable commodity, and the exportation of it may be largely restricted, if not entirely cut off.

There are available scores of examples, arising out of the present war conditions, where the United States has found it necessary to place stringent embargoes upon natural and manufactured products.

If Canada is to be in a position to command special consideration under possible restricted conditions, she must realize the value of her own resources and have them strictly under national control in order that she may be enabled to deal on a basis of *quid pro quo*. When the commodities of commerce are exchanged there must, of course, be a substantial basis for barter. When Germany demanded gold from Switzerland she offered to exchange coal. Suppose that the United States, in the conduct of her commerce, concluded that it was in the general interest of her citizens only to *barter* coal for certain commodities which she specially required, what desirable commodities has Canada to barter?

Canada an Exporter of Electrical Energy

Other than the products of her agricultural lands, mines and forests, there are certain resources in Canada of unique and special value. One of these is the hydro-electric energy which may be developed from Canada's waters, including her equity in international waters. At the present time the United States is importing from Canada about 275,000 horsepower years of electrical energy.* Many factors, of course, enter into the determination of the equivalent of this electrical power in terms of anthracite coal. Electric power has great advantage for many purposes over steam. Speaking in round figures, and taking cognizance of some of these special factors, the electrical power now imported by the United States would be the equivalent of probably not less than 3,000,000 tons of coal—it may be a quantity substantially greater.

Canada has been richly endowed with water-powers, although those serviceable from the standpoint of present economic development should be carefully conserved so that they may be used in the general public interest.

Any estimate for the water-powers of Canada must be presented and considered with a due appreciation of its limitations. The following table representatively sets forth the water-power situation in Canada. By no means may all the water-powers be economically developed:—

Estimate of Water-Power Resources of Canada**

Province	Total possible horse-power.	Developed horse-power.
Ontario	5,800,000	760,000
Quebec	6,000,000	640,000
Nova Scotia	100,000	26,000
New Brunswick	300,000	15,000
Prince Edward Island	3,000	500
Manitoba	....	76,000
Saskatchewan, Alberta, North-West Territories	3,500,000	33,000
British Columbia	3,000,000	250,000
Yukon	100,000	12,700
Total	18,803,000	1,813,200

Men far-sighted in the fields of industry and finance have foreseen the extent to which present and future generations will be increasingly dependent upon power, whether it be steam or hydro-electric.

Concentration of Control

In the United States, for many years past, special efforts have been made to concentrate control of water-powers. Most of the water-powers which are more readily capable of economic development in Canada, as well as in the United States, either have been already developed or are privately controlled. Concentration of ownership is a noticeable feature of this control. It has been authoritatively published that in the United States, in 1913, about 6,300,000 horse-power was controlled by ten groups of interests. This concentration is still going on. Owing both to provincial and federal legislation, it has not been possible for interests so readily to obtain control of water-powers in Canada. Efforts, however, are continually being made to secure the rights for such desirable water-powers as are yet vested in the Crown. The efforts made by the powerful financial interests behind the Long Sault Development Company to obtain control of the almost unequalled power rights at the Long Sault rapids, on the St. Lawrence River, are still in mind.†

Power Monopoly

The public cannot be too well informed respecting the extent to which they may be compelled to pay tribute to those concentrating hydro-electric powers, by reason of the control which such interests have over the distribution and supply of electrical energy.

In this connection no words are better fitted to express what is going on than those of Mr. Gifford Pinchot when he states:—

> "And whoever dominates power, dominates all industry. Have you ever seen a few drops of oil scattered on the water, spreading until they formed a continuous film, which put an end at once to all agitation of the surface? The time for us to agitate this question is now, before the separate circles of centralized control spread into the uniform, unbroken, nation-wide covering of a single gigantic trust. There will be little chance for mere agitation after that. No man at all familiar with the situation can doubt that the time for effective protest is very short. If we do not use it to protect ourselves now we may be very sure that the trust will give hereafter small consideration to the welfare of the average citizen when in conflict with its own."

Respecting the water-powers of the United States and the attempt to create a monopoly of same, Mr. Roosevelt, in accurate, prophetic terms, as true for Canada as the United States, has stated that:—

> "The people of this country are threatened by a monopoly far more powerful, because in far closer touch with their domestic and industrial life, than anything known to our experience. A single generation will see the exhaustion of our natural resources of oil and gas, and such a rise in the price of coal as will make the price of electrically transmitted water-power a controlling factor in transportation, in manufacturing, and in household lighting and heating. Our water-power alone, if fully developed and wisely used, is probably sufficient for our present transportation, industrial, municipal and domestic needs. Most of it is undeveloped, and is still in National or State control. To give away without con-

*Respecting various phases of this subject, consult an article by Arthur V. White on the "Exportation of Electricity," which appeared in the *University Magazine*, October, 1910, pages 460 *et seq.* Consult, also, *Toronto World*, March 18th, 1912; also, "Exportation of Electricity—An International Problem: Relation of a Possible Coal Embargo by United States to a Curtailment or Stoppage of Canada's Electric Power," by Arthur V. White, in *The Canadian Engineer* of January 11th, 1917, pages 21 *et seq.* Consult, also, *Annual Reports of Commission of Conservation*, Ottawa.

**See *Conservation*, Ottawa, for December, 1917.

†For a review of the water-power situation on the St. Lawrence River, consult report of recent annual meeting of the Commission of Conservation, Canada; also *Electrical News*, Toronto, 15th December, 1917.

ditions this, one of the greatest of our resources, would be an act of folly. If we are guilty of it, our children will be forced to pay an annual return upon a capitalization based upon the highest prices which 'the traffic will bear.' They will find themselves face to face with powerful interests entrenched behind the doctrine of 'vested rights' and strengthened by every defence which money can buy and the ingenuity of able corporation lawyers can devise. Long before that time they may, and ve y probably will, have become a consolidated interest, dictating the terms upon which the citizen can conduct his business or earn his livelihood, and not amenable to the wholesome check of local opinion."

This prophecy of the ex-President is daily in process of fulfilment. In view of all the exigencies facing her—both national and international—Canada cannot afford to have great water-powers, like those of her boundary waters, pass into the hands of powerful private interests, but must retain full command of all the nation's resources.

Common Aims and Aspirations a Great Asset

Nothing is further from the thought of the writer than to suggest that it is, or that it would become, the arbitrary desire of the United States to deprive Canada of the coal which at present is so necessary to life in Canada. It is important, however, to take cognizance of the fact that a nation, pressed by the demands of its own people, may be compelled, under certain conditions, to deprive other nations—in part, at least—of even the necessaries of life until the needs of its own citizens are met. No country can be expected to send out of its confines that which is essential to the very existence of its own people.

Canada is, indeed, exceedingly fortunate in being neighbor to a country whose national aims and sympathies are so akin to its own. Our great Ally to the south has extended to Canada specially generous consideration in the present coal shortage. Dr. H. A. Garfield, United States Fuel Controller, has announced that recognition will be given to Canada's needs for coal as though she were one of the States of the Union.

No one can contemplate the hearty efforts made to relieve the suffering begotten of the Halifax catastrophe without placing the greatest value upon the readiness of our neighbors to co-operate where assistance is really needed. In response to the distress of Halifax the governor of Massachusetts telegraphed assuringly: "The people of the Commonwealth of Massachusetts are ready to answer any call that may be made upon us. Massachusetts stands ready to go the limit in rendering every assistance you may be in need of." The governor of Maine telegraphed: "Any help Maine can give is yours," while many others sent corresponding messages. Sentiments like these, however, cannot better be summed up than in the inspiring message sent by President Wilson to:—

"His Excellency the Governor-General of Canada:

"In presence of the awful disaster at Halifax the people of the United States offer to their noble brethren of the Dominion their heartfelt sympathy and grief, as is fitting at this time, when to the ties of kinship and community of speech and of material interests are added the strong bonds of union in the common cause of devotion to the supreme duties of national existence."

Obviously, so long as such sentiments govern men's actions, the people living on the North American continent cannot be deprived of that which is essential to their existence; nevertheless, with the growing scarcity of coal, the United States, no matter what her goodwill or desire for exchange of commodities, may not be able to cope with the prevailing need, and Canadians must be prepared to help themselves by the development of their own fuel resources in a way that they have never done before. There is no doubt that if this effort is made, the United States, in the spirit and disposition recently manifested in the statements above quoted, will see that Canada is fairly dealt with. We should not, however, trespass unduly upon friendly accommodation.

Coal Resources of Canada

The alternative open to Canada, and it is this to which special attention is directed, is to develop, and that as rapidly as possible, her own fuel and power resources, and by co-ordination of transportation and other cognate agencies to provide for the early annual distribution, including reasonable reserves, of fuel to all communities in the Dominion. In some respects it is more important to move coal and have it adequately stored and distributed throughout Canada than it is to move the grain out of the country

The coal fields of Canada may conveniently be divided into four main divisions:—

(1) The bituminous coal fields of Nova Scotia and New Brunswick.

(2) The lignites of Manitoba and Saskatchewan, and the lignites, sub-bituminous and anthracite coal fields of Alberta and the eastern Rocky Mountain region.

(3) The semi-anthracite and bituminous fields of Vancouver Island, Queen Charlotte Island and the interior of British Columbia, and the lignites of Yukon.

(4) The low-grade bituminous and lignites of the Arctic-Mackenzie basin.

The coal areas and estimated quantities for the different provinces are shown in the following table. There should, of course, for practical consideration, be a substantial reduction made in these quantities, due to waste in mining operations:—

Estimated Coal Resources of Canada*

Province	Area of Coal Lands Square miles.	Semi-Anthracite Tons.	Bituminous Tons.	Sub-Bituminous Tons.	Lignite Tons.
Nova Scotia .	521		10,691,000,000		
N. Brunswick	121		166,000,000		
Ontario	10				27,500,000
Manitoba	48				176,000 000
Saskatche'an	13,406				65,793 000,000
Alberta	81,878	845,900,000	217,918,000,000(a)	932,053,000,000	29,095,000,000
Brit. C'l'mbia	6,045		77,923,000,000 (a)		5,715,500,000(b)
Yukon	2,840		275,000,000(a)		5,159,000,000(b)
Northwest Territories	300				5,280,000,000
Arctic Islands	6,000		6,600,000,000		
Total	111,169	845,900,000	313,573,000,000	932,053,000,000	111,286,000,000

(a) Includes some anthracite coal. (b) Includes some sub-bituminous coal.
*Consult "Coal Situation in Canada" by W. J. Dick, in *Transactions of the Canadian Mining Institute*, 1916

Canada's coal and coke production in 1916 was as follows*:—

	1916 Short tons
Nova Scotia	6,912,140
New Brunswick	143,450
Saskatchewan	281,300
Alberta	4,559,054
British Columbia	2,584,061
Yukon	3,300
Total	14,483,395
Distribution of coal production:	
Sold for consumption in Canada	10,701,530
Sold for export to United States	1,451,075
Sold for export to other countries	284,513
Total sales	12,437,118
Used by producers in making coke, etc.	804,814
Used for colliery operation and by workmen	1,241,463
	2,046,277

Peat Resources of Canada

Respecting the peat bogs of Canada, Dr. Eugene Haanel, Director of Mines, Canada, from time to time, has strongly urged the necessity of developing our peat resources, and at the recent annual meeting of the Commission of Conservation of Canada he gave an able, forceful and serious address upon this subject which the people of Canada cannot too carefully consider. Dr. Haanel again affirmed the commercial and economic practicability of peat production. Throughout

(Continued on page 50, Construction News Section)

*From figures issued by Mr. John McLeish, B.A., F.S.S., Chief of Division of Mineral Resources and Statistics, Ottawa.

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Principal Contents of this Issue

HIGHWAY BRIDGE SPECIFICATIONS

The Canadian Society of Civil Engineers has just issued a general specification for steel highway bridges. Much valuable work has apparently been done upon this specification, and the members of the committee are to be congratulated upon the general thoroughness with which the specification has been prepared.

There are a few points, however, upon which the specification might be criticized if it is intended to have it generally adopted throughout Canada as uniform standard specification for all highway bridges. There are other valuable specifications for highway bridges now in use in Canada which differ somewhat from the society's new specification, and a thorough discussion and adjustment of these matters at the forthcoming annual meeting of the society would no doubt do much to facilitate the uniform adoption of the society's specification.

For instance, section 5 permits the use of ¼-in. metal, provided that the bridge is not located near salt water or other deleterious elements. Bridges in inaccessible wooded country, particularly in altitudes subject to damp weather, and especially if more or less roughly constructed and poorly painted, would be safer if a greater thickness of metal were to be specified as the minimum, as it is sometimes impracticable to give close and constant attention to the maintenance of such bridges.

Section 6 specifies a clear width between roadway curbs of not less than 15 ft. With the increasing use of 8-ft. motor trucks, this width as a minimum would seem insufficient for bridges in cities and large towns where two trucks might try to enter the bridge at the same time. And the specification does not state the minimum width of roadways which carry street car tracks.

Section 31, in specifying the method of calculation for floorbeams, hangers and other truss members, does not provide for computation of stresses due to concentrated axle loads.

Section 40 specifies an increase of 50 per cent. in the smaller stress to be computed for members subject to reversal of stress or stresses of opposite kinds. An interesting calculation bearing upon this subject was given in the October 5th, 1916, issue of *The Canadian Engineer* by David A. Molitor, formerly designing engineer of the Toronto Harbor Commission.

Section 89 permits butting joints to be spliced for 50 per cent. of the axial stress in the members. Some other specifications insist upon such joints being fully spliced, and it would appear to be a question as to whether the latter is not the better practice.

Regarding movable bridges, the specification does not provide for protection of the operator by guards over all exposed gears; also no provision is made for the protection of gears situated beneath the bridge floor and exposed to debris falling from the roadway.

OUR COAL PROBLEM

The coal situation on this continent has reached a point at which we may reasonably expect adequate action from the government with a view to future supplies. The coal resources of the United States, while greater than those of Canada, are sorely taxed to meet the demands. The Dominion will not be given preference over other countries in the matter of coal supplies. It will have to fall in line with the export regulations of the United States. An increasing number of commodities is being subjected to embargoes and those already in force are being stiffened. It is pointed out on another page of this issue, in the notable article by Mr. Arthur V. White, a student of this subject, that no country can be expected to send out of its confines that which is essential to the very existence of its own people. No matter what is the goodwill or desire for exchange of commodities, the United States may not be able to cope with the prevailing need. Canadians must be prepared to help themselves by the development of their own fuel resources in a way that they have never done before.

Since the latest editorial on this subject was published in *The Canadian Engineer*, just a week ago, the United States has found it necessary to declare a policy providing that no coal may be exported from that country during 1918 except for purposes contributing materially to the conduct of the war. As pointed out by Mr. White, there is no need to start again learning the A B C of this fuel problem. Officials of the government of Canada, such as those in the Geological Survey, Department of Mines, the Commission of Conservation and other organizations, have knowledge of existing conditions and of practical means by which much of the stress may be relieved. Mr. White says: "To carry out these measures of relief and to place Canada in a reasonably independent position with respect to fuel will take time; but there is no doubt that if matters are dealt with in a broad, statesmanlike manner, and the necessary encouragement of financial and other assistance is given to those who are competent to

handle same, Canada will, at a minimum of effort and expense, be relieved of a menace with respect to her coal supply which threatens not only her economic life, but the physical life and well-being of a large proportion of her citizens."

If our outside supply of coal is cut off, we must look to our peat, lignites, and coal in East and West. Under the circumstances, the public naturally want to know what is being done to obtain this coal in East and West and what is being done for its distribution to the central portions of the Dominion. There is a proper desire to know what action the Dominion government is taking in these matters; whether conferences are being held; whether expert knowledge is being applied; and what time and funds are necessary to obtain lignite and peat in order satisfactorily to relieve the situation, not so much for the present, but more especially for the future.

PROVINCIAL CONSULTING ENGINEERING

Just as this issue goes to press, we are in receipt of thirteen typewritten pages from Mr. Thomas Adams, town-planning adviser of the Commission of Conservation, in reply to the editorial, "Provincial Consulting Engineering," in our issue of December 13th, 1917. As the reading portion of the paper has already been prepared for press, we cannot print Mr. Adams' reply in full until our next issue, in order to avoid missing the mails with this week's paper, but in fairness to Mr. Adams we desire to make immediate acknowledgment of his well-prepared reply.

The editorial above mentioned was written not so much in a spirit of criticism of Mr. Adams' report, as from a desire to do something to curb the growing tendency toward the ill-considered creation of too many provincial bodies with wide and autocratic powers. It is apparent from Mr. Adams' reply, and from another review of his report in the light of the explanations made in his reply, that he intended no slight upon the present efficiency of the work of the municipal and consulting engineers in Canada. In fact, Mr. Adams appears to have been a genuine and staunch friend of the engineering profession in Canada, and we believe that he is fully awake to the possible evils suggested in our previous editorial, and that he would surround any legislation which he might propose, with ample safeguards against injustice to individual engineers.

Mr. Adams is in a position to recommend and secure the employment of engineers by municipalities which now ignore the profession, and his ideas upon the subject are doubtless essentially sound. It is important, however, in the working out of these ideas, that the engineers in Canada should be fully consulted at every turn, and we would suggest that close co-operation between the Commission of Conservation and the new legislative committee of the Canadian Society of Civil Engineers would be productive of the best results.

PERSONALS

Lieut. Jas. Boyd McLachlan, B.Sc., Montreal, has been elected an associate member of the Institution of Civil Engineers.

Walter Robinson McRae, of Toronto, has been elected a member of the American Institute of Electrical Engineers.

Lieut. John Cummings, of the Canadian Railway Troops, has been elected an associate member of the Institution of Civil Engineers.

W. B. Fortune, formerly superintendent of erection of the Quebec Bridge, has been asked to join the American International Corporation, to superintend ship construction.

Carl Ernest Rogers, draftsman for the Montreal Public Service Corporation, Montreal, Que., has been elected an associate member of the American Institute of Electrical Engineers.

Harold L. Woolcott, assistant to light, heat and power superintendent, Canadian Explosives, Limited, Nobel, Ont., has been elected an associate member of the American Institute of Electrical Engineers.

F. F. Backus, general manager of the Toronto, Hamilton & Buffalo Railway, with headquarters at Hamilton, has been appointed railway traffic expert in charge of traffic at the Canadian terminals on the Niagara frontier.

William Stevenson, formerly mining engineer for the Brazilian Collieries, has been appointed district inspector of mines for the Crow's Nest Pass and Pincher Creek districts, Alberta.

Reginald H. Balfour, B.A.Sc., sales manager of the Eugene F. Phillips Electrical Works, Montreal, has been elected a director of that company. The capital of the firm has been increased to $4,000,000, practically all paid up. When interviewed by *The Canadian Engineer*, Mr. Lawford Grant, the general manager, stated that a new charter, with more extensive powers, had been obtained, and admitted that the company looked forward with confidence to greatly increased business, both foreign and domestic, after the war.

Arthur V. White, of Toronto, whose article on the coal situation appears in another part of this issue, is one of the consulting engineers to the Commission of Conservation, and is also consulting engineer to the International Joint Commission on the Lake of the Woods reference. He was formerly consulting engineer with Brown Brothers, London, England, for whom he executed commissions in France, Belgium and the United States. Mr. White became associated with R. A. Ross, of Montreal, in the field investigations of the Ontario Power Commission, the precursor of the Hydro-Electric Cower Commission of Ontario, and later was for a time with the Department of Public Works, Canada. He has persistently urged energetic action with respect to Canada's national fuel and power problems.

OBITUARY

George Kenric Boright, of Cowansville, Que., whose death occurred on January 10th, was an electrical engineer, a graduate of McGill University, Montreal, class of 1910.

The construction of the new mill at the Davidson property in Porcupine is proceeding satisfactorily, and will probably be completed by February.

The problem of conserving the waters of the Grand River is being worked out by N. Cauchon, of Ottawa, who suggests that two districts be developed, not only in the way of conserving the water supply in the tributary districts, but also developing the irrigation system. These districts, in Mr. Cauchon's opinion, should be the Hamilton and Ottawa sections. The Hamilton includes the Grand River as far as Fergus and Elora.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

PROBLEM OF BACKWATER

Some Observations on Subject Based Upon Development on St. Maurice River—Comparisons Between Poirée Formula and that of Mead

By ROMÉO MORRISSETTE

Assistant District Engineer, Public Works Department of Canada, Three Rivers, Que.

THE problem of backwater above dams is taking every day a larger part in engineering activities on account of the increasing development of water powers on large streams and the construction of important dams in connection therewith.

It brings to the engineer a realizing knowledge that riparian and other rights above falls have to be established by the determination of the highest contour attainable by the water surface under conditions encountered by such damming.

The writer in his leisure moments has studied the question, and the purpose of this paper is mainly to point out by using actual records observed on the River St. Maurice, to what extent the formulas ordinarily employed can be accepted.

In 1913, the Laurentide Company, Limited, undertook the construction of a spillway dam. It was at first designed with the crest fixed at elevation 150, referred to the company datum. Later, during the construction, experience suggested the installation of a gate-controlled spillway under Canadian winter conditions, based on the result obtained at Shawinigan Falls by the Shawinigan Water and Power Company, Limited.

A change to a gate spillway having a crest at elevation 140, estimated to raise the normal water level to elevation 160 was then decided on. The flow of the river other than that required for operation of the turbines is controlled by a number of gates which can be raised at any moment, eighteen in number, 40 feet in width and the bottom sill of all the gates resting at elevation 140.

General View of Dam and Power House of the Laurentide Company, Grand'Mere, Que.

Provided the gates were totally opened, different discharges would reach the following elevations:—

10,800 cubic feet per second	.... Elevation	142.90
78,200 " " " "	.... "	150.40
170,000 " " " "	.... "	157.30

But efforts have continuously been made during the last season to keep the water level at nearly a constant elevation independent of the fluctuating flow of the river.

Dam from East Side of River St. Maurice

As the river discharge increased, the number of gates opened was increased proportionately.

The power project called for the installation of eight main power units; and space for two more units, should they be decided on in the future; six of these units requiring a flow of 9,500 cubic feet of water a second under a head of 76½ feet.

The work is now completed and the power development of the Laurentide Power Company, Limited, is at its designed capacity.

The Department of Public Works, of Canada has recorded, at different points along the shores above the dam, the fluctuations of the river, and with the aid of the levelling performed by the Quebec Streams Commission (C.E.C. datum), which has kept records of the elevation of each of these gauges, the water levels have been plotted for different discharges of the river.

The River St. Maurice is a series of cascades and falls which are expected to be used for an extensive power development in the future. Being so near one to the other in certain portions of the stream, and leases being granted one at a time in order that each may be utilized to its full value, it is necessary for the government to be very careful in the acceptance of plans for these future developments.

This last year some engineers were of the opinion that in the development of the Les Forges Rapids contemplated by the St. Maurice Lumber Company, the rights of the

Shawinigan Water and Power Company, Limited, at the foot of Les Gres Falls were liable to be affected by backwater. It caused the writer to give special care to the question.

Two formulæ were used, the first from a French author named Poirée, superintendent of public works in France, and the second from the well-known American author, Mead.

The illustration at the foot of this page shows the backwater above the Laurentide Dam in 1917; two cross-sections measured for the use of formulæ and the type of dam at Grand'Mère.

Five and a half miles from Grand'Mère, there was previously a fall of some 8 feet. At 7.25 miles is Pointe Madeleine, where a gauge exists and a cross-section of the river was surveyed; also on the seventeenth mile at Mekinac.

On the twenty-fifth mile, at Rapide Manigance, is another gauge fixed with the purpose of observing the river in its free course before entering the pondage. These gauges have been cut in the solid rock of the cliff existing at the above-mentioned sites.

The different zeros of the gauges are referred to the two known datums which may be summarized as follows:

	Laurentide datum elevation	C.E.C. elevation.
Grand'Mère	0.00	174.28
Pointe Madeleine	133.30	307.58
Mekinac	144.24	318.62
Rapide Manigance	159.26	333.64

With these datums accepted, observations have been conducted at those three places during a complete period of the year 1917 and the accompanying table shows the conditions for each month, *i.e.*, the highest and lowest water stage.

Date	Grand'Mère Elevation	Pointe Madeleine Gauge	Pointe Madeleine Elevation	Mekinac Gauge	Mekinac Elevation	Rap. Manigance Gauge	Rap. Manigance Elevation	Remarks
April 29	153.25	20.4	153.6	10.00	154.24	5.00	164.26	Low
April 25	152.50	19.9	153.1	10.25	154.49	14.00	173.26	High
May 1	153.20	20.6	153.8	10.00	154.24	6.00	165.26	Low
May 14	153.90	21.8	155.0	12.00	156.24	10.50	169.76	High
June 3	154.00	21.7	154.9	11.25	155.49	5.60	164.86	Low
June 14	155.40	23.2	156.4	13.20	157.64	11.00	170.26	High
July 30	153.70	21.2	154.4	9.66	153.90	3.75	163.01	Low
July 4	154.10	22.0	155.2	12.10	156.34	8.00	167.26	High
August 28	155.30	22.1	155.3	11.30	155.54	3.32	162.58	Low
August 4	154.50	21.7	154.9	11.50	155.74	4.60	163.86	High
September 22 ...	154.90	22.0	155.2	11.20	155.44	1.32	160.58	Low
September 1 ...	154.20	21.6	154.8	11.40	155.64	3.32	162.58	High
October 1	154.90	21.7	154.9	11.00	155.24	1.40	160.66	Low
October 31	154.00	22.2	155.4	12.00	156.24	5.20	164.46	High

These are with a fair degree of accuracy the existing conditions of the water surface, and the small variances in the fluctuations are attributed to the influence of wind on the water surface. The water level observations taken on June 14th, 1917, were chosen on account of the conditions existing at that stage of the river from the dam to the foot of Rapide Manigance. The company maintains the water at level 155 at the dam site, while on April 25th, the date of the maximum annual discharge, the level was lowered to elevation 152.50.

From this experience it may be deduced that the existing backwater above the Grand'Mère Dam varies from 1.0 foot to 2.5 feet, according to the wind and discharge influences encountered on the river.

As stated above, the first formula used was Poirée's:

$$D = H + h - i\,x + \frac{(i\,x)^2}{4\,h}$$

D being the depth of water attained after raising the surface level, at a certain section of the river distant x from the dam.

h is the natural height of the water below the dam.

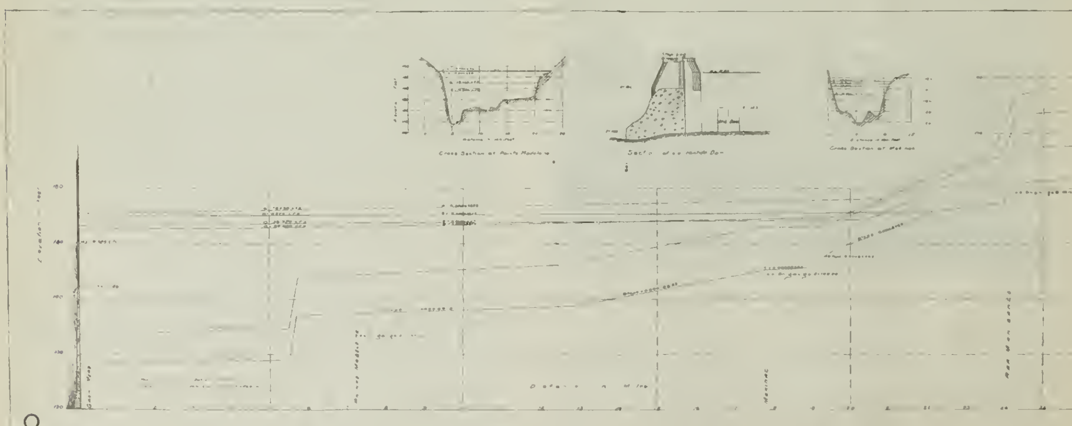
H is the raised height of the surface by the erection of the dam.

i the slope.

x the distance between the sites considered.

The value of i is determined by taking the mean depth across the section, and great care must be taken to determine the slope, as at certain sections there may be a sudden depression of the river bottom and the additional depth modifies the slope.

The water level being raised 23.1 feet corresponding to H and the depth below the crest of the dam being 26.9 corresponding to h, $i = 0.0005491$, $x = 38{,}280$ feet, then we obtain



River St. Maurice, Backwater Above the Dam from Grand'Mere to Mekinac

At Pointe Madeleine—

$$D = 50 - .0005491 \times 38{,}280 + \frac{(.0005491 \times 38{,}280)^2}{4 \times 50}$$
$$= 50 - 21.02 + 22.1 = 30.19$$
$$= 30.19 + 21 = 51.19$$

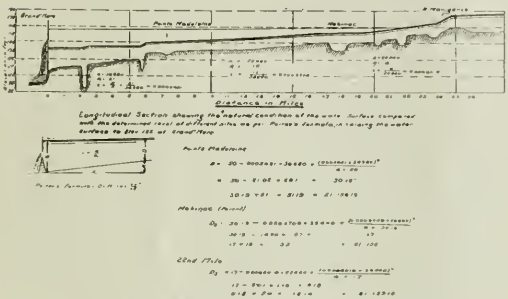
The elevation of the water at Pointe Madeleine will be 156.19.

At Mekinac—

$$H + h = 30.19, \quad i = .0002708, \quad x = 55{,}440$$

$$D_2 = 30.19 - .0002708 \times 55{,}440 + \frac{(.0002708 \times 55{,}440)^2}{4 \times 30.19}$$
$$= 30.19 - 14.99 + 1.87 = 17$$
$$= 17 + 15 = 32$$

The elevation of the water surface at Mekinac is 158.



River St. Maurice, Showing Backwater

It shows that the actual backwater as per the Poirée formula is 3 feet at Mekinac, as the raising of the water at the dam site is considered to remain at elevation 155, while it is 2.24 feet as per observations made of the gauging scales in 1917.

This discrepancy is probably due to the fact that the Poirée formula must have been determined by the largest flow of the river. By the actual problem 78,500 cubic feet per second is the normal discharge, but the maximum one recorded is 170,000 cubic feet per second.

According to Mead, the underlying principle is the comparison of sections, establishing the ratio between the two surfaces, the coefficient of roughness, the velocities under the same quantity of discharge, *i.e.*, when under natural conditions and when an obstruction is located in the river.

The ordinary formula used for opened channel is:

$$Q = Av$$

But by raising the surface level the new condition becomes

$$Q = A'v'$$

Q = discharge.
A = area of the cross-section.
v = velocity in cubic feet per second.

By using the Kutter formula to determine the value of c in the formula

$$v = c\sqrt{rs}$$

where r = hydraulic radius and s = slope, we may substitute

$$Av = A'v'$$
$$Ac\sqrt{rs} = A'c'\sqrt{r's'}$$

Now we can establish the value of h' or the height of the new levels between the dam and the considered site, if h is taken as the difference in elevation between the same two sites under natural conditions. We then deduce

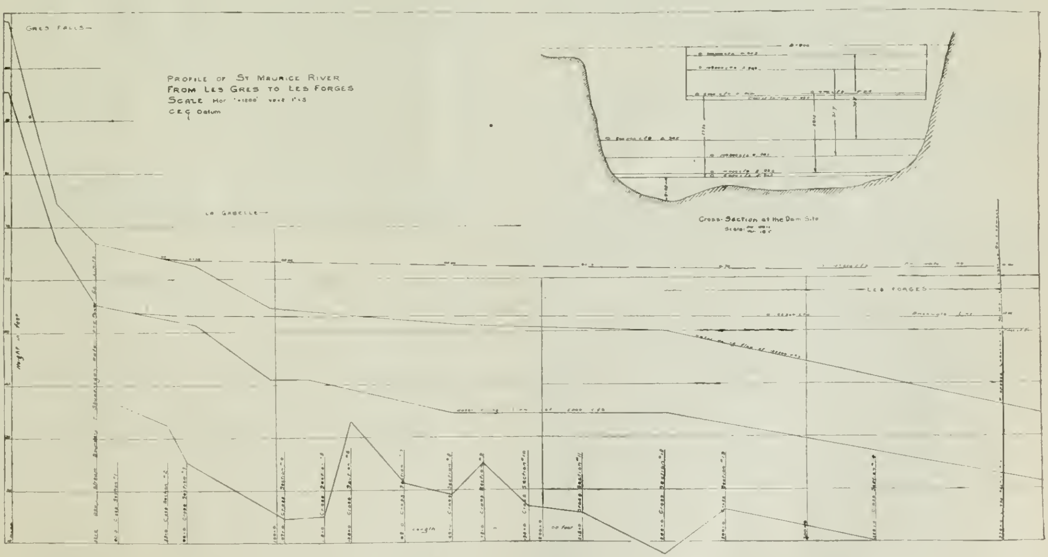
$$h : ac\sqrt{rs} :: h' : a'c'\sqrt{r's'}$$

or

$$h' = \frac{h \times A^2c^2r}{A'^2\,c'^2\,r'}$$

The value of h' will be at Pointe Madeleine:

Area.	W.P.	r	Slope.	c	v	Q	Remarks.
51,289	1,894	27.08	.00002525	58.24	1.54	78,200	Raised
48,636	1,872	24.91	.00000842	15.27	0.22	10,800	Raised
32,268	1,619	19.93	.0005491	23.27	2.42	78,200	Natural
19,469	1,535	12.68	.0005491	6.55	0.55	10,800	Natural



Profile of St. Maurice River from Les Gres to Les Forges. (C.E.C. Datum)

Substituting

$$h' = \frac{23.1 \times 32,208^2 \times 19.93 \times 23.27^2}{51,289^2 \times 27.08 \times 58.24^2} = 1.07$$

Elevation at the dam site	155.40
Backwater at Pointe Madeleine	1.07
Elevation at Pointe Madeleine	156.47

At Mekinac—

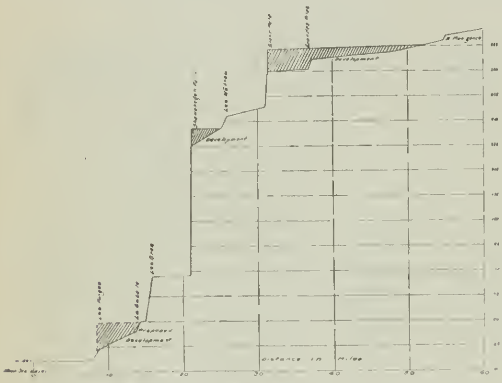
Area.	W.P.	r	Slope.	c	v	Q	Remarks.
27,446	1,088	25.22	.00002525	107.6	2.79	78,200	Raised
22,286	1,050	22.08	.0002708	45.58	3.51	78,200	Natural

Substituting the value in the Mead formula

$$h' = \frac{10.47 \times 22,286^2 \times 22.08 \times 45.58^2}{27,446^2 \times 25.22 \times 107.60^2} = 109$$

Elevation at Pointe Madeleine	156.47
Backwater at Mekinac	1.09
Elevation at Mekinac	157.56

The actual backwater as per the Mead formula is 2.16 feet at Mekinac, for a discharge of 78,200 cubic feet per second,



Profile of River St. Maurice from Three Rivers to Manigance Rapids

while it is 2.24 for the same discharge as stated above in the comparison of actual and theoretical results obtained by the Poirée formula.

Les Forges Rapides Development

In 1916, by their flowing rights, the St. Maurice Lumber Company, as owners of Les Forges Rapides and La Gabelle Falls, were entitled to utilize as pondage all the area of the River from Les Forges Rapides, and up to a certain division line fixed by the provincial government at the foot of Les Gres Falls, the property of the Shawinigan Water and Power, Limited.

The former company submitted for approval plans of an ordinary concrete spillway dam with a crest at elevation 49.5 (C.E.C. datum), and their engineers maintained that the crest elevation was so designed as not to interfere with the rights of their neighbors, or in other words, they represented that at any time,. and under any natural conditions the river at that section was to remain free and the water to pass through, as if no impediment existed below, which the latter contested.

In the table submitted, the percentage of duration of each flow recorded for a period of seventeen years by the Shawinigan Water and Power Company, Limited, is represented; it gives an idea of what may be expected. However, the erection of La Loutre reservoir will have an appreciable effect on the freshets. Such a large flow as that of 1904 will not often happen in the future.

Observations were conducted by the government and the two interested companies, section surveyed, levels run along the basin and gauge readings recorded and with all these data the table at the foot of this page was prepared.

With a discharge of 125,500 cubic feet per second, the backwater should be 2.50 feet, using the Mead formula, or should attain a point about 3.90 feet below the .vater level for the same discharge flowing under natural conditions at the said division line at Les Gres Falls.

	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	Average	Percentage of the time
6000 c/s	365	310	345	365	365	356	330	365	352	358	365	346	354	343	350	355	369	346	95%
10000-	296	182	279	308	279	213	161	296	248	265	291	148	269	298	200	167	183	243	67%
20000	211	110	201	184	181	93	83	201	98	240	138	89	157	176	75	97	96	141	38%
50000-	61	56	96	40	55	24	31	50	55	44	52	37	66	33	11	33	56	49	13%
100000-	6	13	13	1	14			5	28	21	8	3	4	13		4	18	9	3%
150000-		1			2				2	6				2				0 8	0 2%

Table Showing Average Time During Which Different Discharges Occurred for a Period of Seventeen Years

The discharge of 125,500 cubic feet per second is considered as one of the largest for the future on account of the controlling effect of the above-mentioned reservoir.

From all these actual observed conditions we may deduce that the greatest care is necessary in the choice of the sections. The determination of the different data forming the essential part of the problem is greatly influenced by the bottom irregularities, natural basins or contractions along the stream.

The two authors mentioned have established formulas close enough to the existing state of backwater above the dam. But all depends on the accuracy of the preliminary work and the care in the observations conducted on the field.

Section No.	Area.	W.P.	Q	r	$v = \frac{Q}{A}$	$s = \frac{h}{L}$	c	h	h_1	Elevation.	Remarks.
3	15,607	653	125,500	23.9	8.04	.0013	46.70	3.2			
3	15,851	660	125,500	24.0	7.89		96.40		0.81	64.34	Raised
4	15,181	645	125,500	23.6	8.26	.0024	34.60	8.6			
4	20,708	775	125,500	26.7	6.06		97.60		0.51	63.53	Raised
8	16,277	744	125,500	21.9	7.71	.0006	67.00	3.5			
8	25,172	816	125,500	30.8	4.99		100.40		0.46	63.02	Raised
11	19,824	786	125,500	25.2	6.35	.0001	127.0	0.5			
11	29,196	959	125,500	30.4	4.29		100.0		0.39	62.56	Raised
13	14,067	806	125,500	17.4	8.92	.0006	87.4	3.2			
13	26,210	959	125,500	27.3	4.79		98.0		0.47	62.17	Raised
15	17,441	1,144	125,500	15.2	7.19	.0012	51.4	1.3			
15	50,992	1,426	125,500	35.6	2.46		130.0		0.10	61.70	Raised
					.. Dam site					61.60	Raised

RECENT DEVELOPMENTS IN THE DESIGN AND CONSTRUCTION OF ROAD SURFACES

By H. E. Eltinge Breed

(Concluded from last week's issue.)

So far as bituminous macadam when laid in the penetration method is concerned, until the last two years this type of pavement was built in many cases under practically the same specifications for asphalts as for tars. These materials have different characteristics; that is, the asphalt will generally stay fairly well to the surface and quite often in warm weather will bleed up, requiring additional stone surface to take up the excess; on the other hand, the tar has a tendency to work down and, with the subsequent oxidation, to leave no material on the surface which is therefore prone to disintegrate. A number of experiments to alleviate this condition have been tried. One of these was on a road I happened to build and the construction was mainly as follows:

After the proper thickness of stone had been spread it was lightly rolled once to shape it to form to the crown of the road. It was then filled with No. 1 and No. 2 stone in an amount just sufficient to fill the voids. (If, however, the stone used is of such character as will crush under the roller, a smaller amount of No. 1 and No. 2 stone mixed should be used.) The top course was then again rolled, after which the bituminous material (tar), heated to a temperature of between 200 and 300° F., was evenly spread over the surface by the use of an approved pressure distributor, operating under a pressure of 50 lbs. per square inch, or more if necessary. The amount of bituminous material used for this application approximated 1¾ gallons per square yard for a compacted top course 3 inches thick.

The surface was immediately covered with a layer of clean No. 1 and No. 2 broken stone mixed, after which it was again rolled and additional No. 1 and No. 2 broken stone mixed, applied and broomed until the voids in the No. 3 or top-course stone were entirely filled. After this was done, all loose stone was swept from the surface and a seal coat of approximately ½ gallon of bituminous material per square yard was applied by means of an approved pressure distributor. The road was immediately covered with No. 1 broken stone which was spread and broomed and again rolled. The rolling was continued and additional No. 1 stone added until a smooth, uniform and thoroughly compacted surface was produced.

The first road on which this was tried is now two years old and has been under average heavy traffic. The results are exceptionally good, so that all of our penetration work done with tar will be conducted according to the same specification.

Another method that has given good results with this type of pavement and which incurs lower first cost where the local stone is not of good enough quality for top surface, is to place a veneer top of ¾-in. trap rock, or other stone of high quality, on the ordinary top course after the first pour of bituminous material has been made. This course should be from ¾ in. to 1 in. thick and is poured and finished with the usual squeegee course, where under observation it has given uniformly good results and a larger saving is made in using materials for two-thirds of the top course.

Concrete Pavement

In finishing the surface of concrete pavement, the belt has largely taken the place of the finishing machine and also of the floating. It has many advocates because it is cheaper than either of the other methods and at the same time gives a good, smooth, easy riding surface.

Another method of finishing concrete surfaces is by the roller. Its advocates claim that on account of the importance of a proper wet content for concrete the roller, if properly used, will not only give a good finish but also greater strength by taking off the excess water and giving the stiff mixture which it is impracticable to use in most concrete road work. This method, which has been in general use in the city of Macon, Ga., was originally developed to remove any unevenness in the surface.

The concealed type of joint is another method in use to make easier riding qualities over the joints in concrete. It has been impossible always to finish them so as to leave a smooth surface, but when the joints are depressed from an inch to 1½ inches below the pavement this unevenness has been obviated. In Fulton County, Georgia, where the concealed joint has been used, good results have been obtained.

Resurfacing of concrete with 3-in. concrete has been tried with success in Wayne County, Michigan. At the same time this work was done the pavement was widened from 16 to 20 ft. and after a year's wear under average heavy traffic conditions the work is very satisfactory. One interesting feature of this work is that after the old concrete surface had been levelled up it was wet and a mixture of hot Tarvia "A" and "X" poured over it. This spread out in a fine layer and made a joint between the old and the new work. The whole work was resurfaced and while the surface has some cracks no serious ones have developed up to the present time. Milwaukee County, Wisconsin, has also done some of this resurfacing.

Here is another method which saves in cost because it uses in part poor local material and decreases the importation of expensive material: The local material is used in proportions of 1 : 2 : 4 or 1 : 2½ : 5 for the lower 3½ to 4½ ins. of the pavement. On it is placed a top course of concrete 2½ ins. thick composed of trap rock or other tough, durable aggregate in proportions of 1 : 1½ : 3. A fairly dry mix is necessary in this type of construction, but contrary to general expectations the cost of manipulation is increased only to a very slight degree.

Brick, Monolithic

This type of construction has many advocates because full beam action can be developed in a structure of this type. The brick are laid in the green concrete as the work progresses. One successful piece of this class of work is to be found in Paris, Ill.

Another new type of brick construction is that known as the cement sand cushion. The cement sand bed is made of a mixture of one part of cement and four parts of sand which shall be not greater than 1 in. after rolling. The sand and cement must be thoroughly mixed before placing. After the bed has been levelled off in the usual manner, it is rolled with a roller weighing about 300 lbs., after which the brick are laid and rolled. Each day's work has to be fully completed. Before the grout is applied the brick must be thoroughly wet by sprinkling so as to set up the cement sand bed. Then the pavement is grouted as usual. A good example of this can be seen in the entrance to the Pennsylvania Railroad Station in New York City, where the work was laid in 1910 and is in excellent condition to-day under the strain of very heavy and diversified traffic.

There is another tendency in brick surfacing which from an economic standpoint has many advantages. That is the use of 3½-in. or 3-in. brick in place of the ordinary

paver which is 4 ins. in depth. In the use of the 3-in. brick there is a saving of one-quarter in the freight charges and a consequent saving of handling. This type of work has been done in a number of instances and has every indication of being satisfactory. Some work under consideration may use 2½-in. and even 2-in. brick and if successful the resulting economies will make brick pavements feasible in many localities.

Laboratory Work in Relation to Road Surfacing

There should be laboratory control in connection with every piece of highway work because to insure good work the materials must be up to some standard which has proven its adequacy in service.

Field tests by the men in charge of the work should be made in a practical manner and in conjunction with those of the laboratory in order that a constant check may be had upon the materials going into the work.

As a matter of cost it may not be entirely practical for every department in its early stages of development to have a fully equipped laboratory, but if there is a sufficient demand for laboratory work to guarantee enough of it, the commercial laboratories in existence would be willing to equip themselves to render this service at a nominal charge. This would stabilize all work done and the amount expended for the service would be the cheapest kind of insurance.

Good slag is essential if it is to be used in any type of pavements. The tests on slag run in the standard stone abrasion machine were not indicative of quality or comparable with different qualities of stone. It was learned that the material worn from the sample during the test filled the corners of the closed pot, and as soon as sufficient material had accumulated, a cushion was formed which greatly reduced the abrasion.

We designed a new pot to remedy this condition. This is of the same size and shape as the standard pot, but it is slotted at intervals to allow the worn-off material to escape and to prevent cushioning. This new test has been very successful in determining qualities of slag.

It has also been used in testing gravel with promising results. The aim in the gravel testing is to determine what gravel is suitable for use as coarse aggregate in concrete road surfacing. The better known gravels of the State, which have been proved successful by service test, have been tested in this machine and the results used as a standard for the judging of other gravels.

In testing gravels, several methods have been tried with charges of steel shot both in the closed and the slotted pot. So far, judging from results obtained, the most reliable method is in using the slotted pot without any charge.

CANADIAN SOCIETY FINANCES

The gross income of the Canadian Society of Civil Engineers was slightly higher in 1917 than for any previous year. The total income was $25,698, as compared with $23,727 in 1916, which was the previous high-water mark.

The expenses for 1917 were $25,210, compared with $20,085 in 1916, so that the excess of receipts over expenditures in 1917 was $488, compared with $3,642 in 1916.

The larger income was due mainly to an increase of over $2,000 in the current fees collected. The larger expenditure was chiefly due to increases of $1,818 in general items, $773 in refunds to branches, and $2,693 in salaries. The salary increase was mainly due to the appointment of a secretary who would devote his entire time to the society's affairs.

In commenting upon the annual statement of the auditors, R. A. Ross, chairman of the finance committee, says: "In spite of greater exertions, the arrears collected are practically the same as for the two previous years, indicating that most of the cream has been extracted. Current fees collected show recovery in spite of war and consequent remission of fees to active service members. . . . In spite, however, of the absence at the front of over 850 members, whose fees would total about $6,000, and of increased salaries, the society is in a position to show a small excess of receipts, which should increase next year when the effects of new activities become evident."

The assets of the society now amount to $111,160, approximately just the same as last year. There is a reduction in cash on hand and in the bank, but this is more than offset by the reduction in accounts payable and by the investment of $1,000 as part payment on a $5,000 Victory Loan bond. The largest asset is the property at 176 Mansfield Street, Montreal, which is valued at $89,041, but on which there is a $20,000 mortgage. The estimated value of arrears of fees is still carried forward at $5,000, which would appear to be warranted by the fact that over $6,000 arrears have been collected each year for the past three years. The cash and investments amount to about $8,000, while books and furniture are valued at nearly $9,000. The liabilities, other than the mortgage, amount to only $4,640.

TORONTO BRANCH, CAN. SOC. C.E.

Prof. Peter Gillespie, of the University of Toronto, has been elected chairman, for the year 1918, of the Toronto Branch, Canadian Society of Civil Engineers. Geo. Hogarth, chief engineer of highways of the province of Ontario, will be secretary, and the executive committee will consist of the following:—

J. R. W. Ambrose, chief engineer of the Toronto Terminals Railway Co.; Willis Chipman, consulting engineer; E. L. Cousins, manager of the Toronto Harbor Commission; Prof. H. E. T. Haultain, of the University of Toronto; E. G. Hewson, division engineer, G.T.R.; and R. O. Wynne-Roberts, consulting engineer.

There are 171 corporate members of the branch at home and about 30 in active military service. Of about 100 junior and student members of the branch, fully three-quarters are in khaki. Therefore, of the entire branch membership, totaling about 300, just about one-third are in the army. In connection with the election just held, 171 ballots were sent out, of which 62 were marked and returned to the secretary by mail or at the meeting last week. About thirty-five members attended the meeting.

SASKATCHEWAN BRANCH, CAN. SOC. C.E.

The annual meeting of the Saskatchewan Branch of the Canadian Society of Civil Engineers was held January 10th, when the following officers were elected:—

Chairman, G. D. Mackie, Moose Jaw; vice-chairman, H. S. Carpenter, Regina; secretary-treasurer, J. N. de Stein, Regina; executive committee, H. R. Mackenzie, Regina; E. G. W. Montgomery, Regina; W. H. Greene, Moose Jaw; C. J. Yorath, Saskatoon; J. E. Underwood, Saskatoon

DRAINAGE OF IRRIGATED LANDS*

By J. L. Burkholder

SEEPAGE usually results in one of two ways, either from a rising of the ground-water above its original level or from the retention of applied irrigation-water by an impervious stratum at a comparatively short distance from the surface. Seepage caused by a general rising of the ground-water usually involves larger areas, and is more common than that caused by impervious strata. In the former case, the underground-water passages, which are sufficient in capacity for the ordinary flow of underground water, are choked by the added irrigation supply, and a gradual ponding in the soil takes place. In the winter, when the irrigation water is wholly or partly shut off, the ground water surface lowers, only to rise

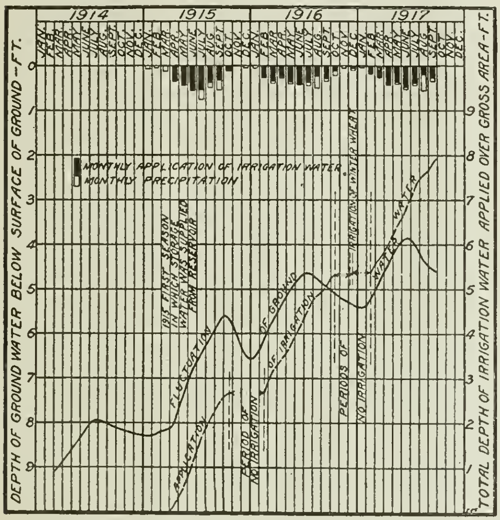


Fig. 1.—Ground-water Fluctuations and Use of Water in Rio Grande Valley

again to a greater elevation during the succeeding irrigation season.

The surface of the ground water is represented by a series of peaks and valleys, which correspond to the seasonal use of water on the land. The peaks increase steadily in height, and finally reach the ground surface at low points. Water stands in these during the irrigation season, only to disappear during the winter. Fig. 1 shows the fluctuation of ground water and the application of irrigation water on 8,500 acres in the Rio Grande valley. The ground-water curve is based on the records of 20 wells in various parts of the tract. The net area irrigated was 5,300 acres, and the average depth of water applied was 4.3 ft., corresponding to 2.7 ft. over the entire 8,500 acres. Where the water stands on the surface, or where the ground-water level is near enough to the surface to be affected by capillary attraction, the resulting evaporation causes the deposition of "alkali" salts.

The flow of underground water, like the flow of surface water, follows the direction of greatest slope, but on account of friction of the soil particles, the movement is slow. If irrigation losses are large, the supply of ground water exceeds the amount handled by natural movement and there is seepage, even on land with a considerable slope.

Deep drains keep the ground-water level at a sufficient depth below the surface to prevent the rise of "alkali". They do not empty the underground reservoir, but simply reduce the peak of the ground-water surface.

A study of Figs. 1, 2 and 3 shows that the loss of a comparatively small quantity of water by deep percolation

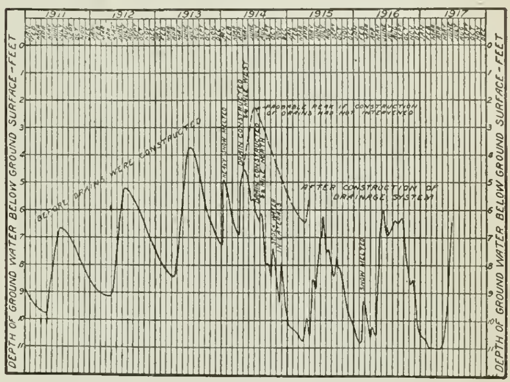


Fig. 2.—Ground-water Fluctuations in Part of Boise Valley, Idaho

necessitates the construction of an extensive drainage system. In Fig. 1, note how closely the curve representing the ground water responds to the use of irrigation water. This curve drops rapidly when irrigation stops, showing the effect of the natural underground drainage.

The financial loss caused by deep percolation does not stop with the construction of a drainage system. Drains

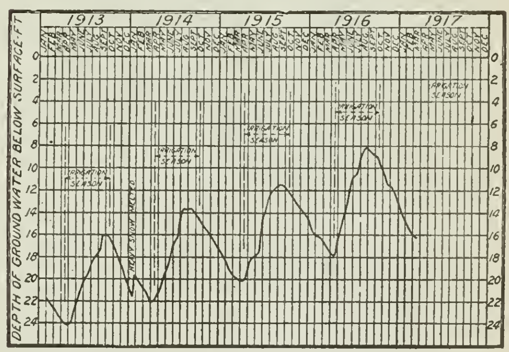


Fig. 3.—Ground Water in Boise Valley, Idaho.

are not a "cure-all" for seepage. After each irrigation a "peak" of ground water remains, the size depending on the care taken by the irrigators. This ground water must spread laterally and enter the drains, if the soils are to be properly aerated and injury from "alkali" prevented. If there is a continual overabundance of water applied this "peak" remains so close to the surface as to make the root space shallow. In addition, much of the plant food is removed by the continual motion of free water in the soil.

*Abstract from "Reclamation Record."

EFFICIENCY OF THE APPLICATION OF BITUMINOUS MATERIALS FOR SURFACE TREATMENTS ON GRAVEL AND BROKEN STONE ROADS*

By Julius Adler

Engineer of Tests, Pennsylvania State Highway Department.

ABOUT ten years ago the dual problem of dust prevention and road preservation—to borrow the commonly used terms—first assumed importance. A large mileage of hard surface roads which were threatened with destruction; and a variety of bituminous products, differing widely in origin, consistency and behavior—many of which have now disappeared entirely from the market—were applied in the effort to preserve them. Prior to that time a good macadam road had been defined as one having a smooth, hard surface, furnishing a water-tight roof for the earth subgrade beneath; and acting as a "more or less rigid stratum to distribute the concentrated pressure of wheel loads"—in other words, a foundation and wearing surface in one. Under this description, however, were included many roads which were in no wise suited to carry successfully a bituminous surface treatment.

The present-day macadam road requires at least equal rigidity, and regularity of surface contour has assumed even greater importance; but in addition it must meet the special requirement of presenting a suitable surface for the application of a liquid bituminous material. For the latter purpose there is fairly general agreement as to the necessity for a clean mosaic surface, with a maximum exposed area of tightly locked, coarse road metal and the least possible part of the surface occupied or covered by screenings, dust, or other fine material. If a graded aggregate has been used in the construction or resurfacing of the road it is essential that the distribution of the different sizes shall be uniform, the smaller pieces tending as nearly as possible to assist in locking the larger pieces and to reduce the size of the individual surface voids surrounding them; and that there shall be a complete absence of "pockets" of segregated small sizes. If this result is accomplished successfully the bitumen, after application, will have a direct and approximately uniform anchorage to the surfaces of pieces of solidly embedded road metal, and the gaps between the individual pieces, which must be filled and spanned by the mixture of bituminous material and mineral covering, will be of the least practical size. Stated in other words, it may be said that it is now an established fact that the success of bituminous surface treatments is far more dependent upon the condition of the roadway treated than upon the kind of bituminous material used or any other details in the process of application.

After making reasonable allowance for availability of bituminous materials and for all the differences in the climatic and traffic conditions to which the bituminous surface treated road will be exposed, it appears that a greater and more desirable degree of uniformity of practice in connection with this work will be reached only by more careful inquiry into the real purposes of bituminous surface treatments—leading to a more general agreement among engineers as to the general types of materials and methods to be employed to meet similar sets of conditions. Bituminous surface treatments at first appear to serve a number of distinct purposes in the preservation of the road surface but upon analysis these may be placed into two classes: (*a*) Priming and binding the upper portion of the road crust; (*b*) sealing and smoothing the road surface.

The screenings or fine material occupying the small voids or pockets surrounding the coarser pieces of aggregate must be saturated by the bituminous material to a degree that the particles will adhere to one another as well as to the contact surfaces of the adjacent road metal. This should further result in the formation of an irregular, but continuous, water-proofing layer below the road surface, serving to intercept water, drawn by capillary attraction from the subgrade. Contrasted with this, the sealing action consists in the formation of a continuous film of bitumen or bitumen-coated particles, coating the exposed surfaces of the upper layer of road metal and filling and bridging the gaps between the individual pieces of the latter with a tough, elastic mixture of mineral covering material and bitumen. This seal coat, so long as it remains intact, serves to waterproof the road surface and tends to produce a generally smooth and slightly resilient surface, lowering tractive resistance, reducing the abrasive and picking action of horse-drawn traffic and offering more effective resistance to the shearing and displacing action of motor-driven traffic.

In the selection of the proper material for application to a stone or gravel road these two functions should be weighted according to the necessities of the case. Roads receiving their first treatment undoubtedly require the priming action above described, as the first essential to successful results. Contrary to the practice of some localities, this would seem to limit first application materials to those which are liquid at normal air temperature. The full range of products which can be applied successfully for this purpose is not yet known, but in a given case the selection of the particular material to be used should undoubtedly be influenced by the question of whether the priming coat will be followed by the seal coat within a period of a day, a month, or whether an entire season would elapse. In the latter case, it is obvious that a heavier bodied material would be required than in the first instance. On the other hand, it cannot safely be assumed that all bituminous materials—regardless of character or origin—are necessarily of the same value as primers simply because they are of approximately the same liquid consistency. Observation and experience have taught that there is a considerable difference in behavior in this respect, and while no specifications as yet attempt to cover definitely this particular point, it has been suggested that a study of the surface tension of different products of about the same consistency be made, since this property bears a direct relation to the height to which a liquid will rise in a capillary tube, which may also be regarded as a measure of its ability to creep down into the irregular capillary tubes formed between the fine particles of mineral matter in a road surface.

In this same connection it should be remembered that just as the usual "hot application" bituminous material is liquid only so long as it retains its heat, similarly, many products which are liquid at normal temperature may remain so only so long as they retain their volatile constituents. If the latter are lost too quickly, the bituminous material will thicken so rapidly as to fail to serve its purpose as a primer. If, as is frequently the case, a bituminous material for first application must serve not only as a primer, but also provide sufficient surface sealing so that the road may safely carry a season's traffic, the most desirable product is that which is so constituted that,

*Paper presented before Section "D" of the American Association for the Advancement of Science, December 28th, 1917.

while not changing in consistency too rapidly upon exposure to the air, it will nevertheless leave a residue of heavier consistency on the road surface to serve as a cementing material for a partial seal coat.

Considering the second case, if the bituminous material is to serve almost entirely in the production or maintenance of a seal coat, the character of the residual bituminous material finally left on the road surface is the most important factor to be considered. Insofar as consistency at the time of application is concerned, the necessity for a material liquid at ordinary air temperature is largely removed where priming or penetrating qualities are required. There is, however, a greater assurance of a complete union between the old and newly applied material, and of an enlivening of the former (in the case of roads which have been treated in previous seasons), with the use of this class of material. If a liquid material is to be used for this purpose, it becomes quite important, from the standpoint of the convenience of the travelling public, that it should contain a considerable percentage of volatile material, since a product of the reverse character, placed and held on the surface of a fairly impervious road, creates a slippery and unsafe condition which requires excessive time for correction because of its slow volatilization. These considerations indicate that a given liquid bituminous product can hardly be equally suitable for use both as a priming and sealing material. Whether a hot or cold application material is used in seal coat, or retreatment work, the essential point is that the original bituminous material, or the final residue from it, shall be of the proper consistency, adhesive, pliable and elastic, and retain these properties under temperature changes, aging, and exposure to traffic and atmospheric agencies.

The influence of the character or quality of the road metal on the success of bituminous surface treatments is still an uncertain factor. Material of an argillaceous character; that is, argillaceous sandstones or limestones, slates and argyllite, and bank gravel with a high clay content, have been noted to affect the results adversely. This may be due largely to the usual presence of earthy or shaley material in the screenings used in bonding the road, and again to the smooth, highly polished surfaces of the fragments of some of these varieties of rock. Hard, crystalline, metamorphic rocks, of the general character of gneiss, are difficult to bond with their own screenings and are slow in forming a solid, impervious crust. The road surface frequently ravels in spots under traffic before the first bituminous application is made, thus interfering with the complete success of the treatment. Occasional instances have also been noted of stone so soft as to be crushed by the weight of traffic beneath the bituminous seal, causing a local breaking up of the bituminous seal. In general, however, the requirements for stone for surfaces intended to receive bituminous treatments are less exacting than in the case of waterbound macadam, and a hard limestone may be used with the same bituminous material and under almost as severe traffic conditions, and give as successful results as trap rock.

The completed surface treatment is immediately subjected to the destructive influence of traffic, atmospheric and climatic agencies. As regards traffic, it is evident that the life and completeness of the bituminous seal depend entirely or directly upon the ability of the underlying road crust to furnish complete and uniform support. Surface treatments for at least the first few years of their application can scarcely be regarded as more than films; and however perfect or elastic this film may be it is questionable, in view of its small depth and the impact which must be transmitted to the piece of road metal beneath, whether it can reasonably be expected to withstand the pounding of the hoofs and wheels of heavy horse-drawn traffic or the shearing action of heavily laden solid-tired trucks, especially when acting in the presence of a coating of mud or melting snow or ice on the road surface. In this connection, excellent examples of bituminous surface treated roads in suburban sections of cities in which a real estate development unexpectedly begins, have been seen to deteriorate rapidly; while on the other hand, inferior roads in localities where the surface is blanketed with snow or ice, which remains from the early part of the winter to the final spring thaw, are found to be preserved in excellent condition.

It will always be difficult to define the exact localities in which bituminous surface treated roads can be relied upon to meet all requirements because of the uncertainty of changes in the amount and character of traffic resulting from unexpected developments in industrial operations of all sorts as well as temporary severe increases resulting from a condition such as previously mentioned. On the other hand, systematically maintained, bituminous treated roads have been found to be an entire success under the condition for which they were originally designed; that is, for large amounts of motor traffic. In an analysis of the cost of such roads in Maryland in 1917, Mr. H. G. Shirley has shown that the annual maintenance cost per mile of bituminous surface treated roads divided by the annual tonnage passing over the road is less for main automobile traffic routes than for any other set of traffic conditions. Experience up to date may be said to have demonstrated that insofar as traffic is concerned the well-built bituminous surface treated road will give satisfactory service in many localities where there is reasonable assurance of a continued preponderance of pneumatic-tired motor traffic with lesser amounts of solid-tired motor and heavy horse-drawn traffic.

As regards climatic conditions, it has already been suggested that roads of this type built and maintained by similar methods, apparently encounter the most adverse condition when exposed to a winter climate which includes alternate freezing and thawing, coupled with the maintenance of traffic over the road throughout the winter and early spring season; while the reverse condition may act as an actual preservative of a bituminous surface treatment.

All bituminous materials will deteriorate to some degree on a complete bituminous seal, and have been found to contain a very appreciable amount of moisture during the early spring, drawn undoubtedly from the road, under freezing temperature, which does more damage to bituminous surface films than any other natural agency,—especially in the case of roads which, as a result of careless construction, etc., do not conform to some of the requirements previously described. As a further illustration of the importance of frost action, it is reported that in extreme southern States it is possible to maintain bituminous treated gravel roads as a permanent form of construction, insofar, of course, as this type can be called permanent; while in certain New England States, with careful attention to drainage, it is found impossible to hold the impervious bituminous surface on gravel roads subjected to the heaving and consequent settling of the spring break-up. There is no assurance, of course, that the gravel in the two cases is of equal quality, but all indications point to this as an illustration of the limitations imposed by climatic conditions upon the possible success of this type of construction.

Assuming that traffic and climatic conditions are reasonably favorable to this class of work, it still remains to

be determined what are its further limitations. Improved methods of construction, more attention to details in the construction of the road and better selection and application of bituminous materials, on the one hand, may to some degree widen even its present range of usefulness. Repeated annual treatments, however, introduce problems which are not yet entirely solved. More or less heavy, unstable carpets of bituminous material produced during some of the early stages of this work proved entirely unsuccessful. Successive applications (varying very considerably with the kinds of material used and the nature of the traffic over the road) show indications of producing a similar condition only modified by the facts that the general character of the materials in use is now more suitable than some of the early ones, and that the production of a carpet by a succession of thin layers thoroughly united, and having good adhesion to the surface beneath, is more apt to produce a stable combination. On the other hand, attempts to re-surface old macadam roads with bituminous concrete mixtures, where the mineral aggregate is scientifically graded and the bitumen of selected consistency and quality, have been found not to meet with the unfailing results which should be expected from the type of construction under discussion.

From an economical standpoint it may, under some conditions, be demonstrated that there is a possible saving in the construction, or more frequently the resurfacing, of an existing macadam road, to be maintained by systematic surface treatments, as compared to the construction of one of the higher priced and so-called permanent types of surfaces. Generally speaking, however, it will be found that the combined cost of an annual bituminous treatment with the caretaker or patrol system, totalling from $500 to as high as $1,000 per mile of 16-ft. roadway in various localities, represents an annual charge in excess of the maintenance, interest on the difference in first cost, and depreciation on a road of greater initial cost, consequently the most apparent recommendation for the bituminous treated road lies in its relatively low first cost, making possible a larger total mileage with the same outlay.

Present hopes for enlarging the field of success and usefulness of this type of work lie in the more careful construction of the original road, more scientific selection of bituminous materials so as best to serve the two functions considered as necessary, and the adoption of systematic and continuous maintenance, so that it may become possible to preserve at least a considerable proportion of these roads in satisfactory condition with fewer than annual complete re-treatments and at a consequent lower annual maintenance cost.

CHARTER MEMBERS, CAN. SOC. C.E.

Of the nineteen charter members of the Canadian Society of Civil Engineers, only six are now living, *viz.*, Sir John Kennedy, of Montreal; Hugh David Lumsden, of Orillia, Ont.; Brig.-Gen. Henry Norlande Ruttan, of Winnipeg; Sir Collingwood Schreiber, of Ottawa; Percival W. St. George, of Montreal; and Herbert Wallis, of Montreal. All six are in consulting practice.

Sir John Kennedy is a past president and honorary member of the society. H. D. Lumsden is a member and past president. General Ruttan is a member and past president. Sir Collingwood Schreiber is an honorary member and was a councillor in 1887 and 1888. P. W. St. George is a member and was vice-president in 1894, 1898, 1899 and 1900. Mr. Wallis is a member and past president.

THE DIFFUSION OF SEWAGE*

FROM experiments made by the Metropolitan Sewage Commission of New York in the laboratory and in the open harbor several interesting conclusions were drawn. In still water, sewage will first rise toward the surface or fall toward the bottom, depending upon the relative specific gravity of the two liquids. In sea water it will rise, while in fresh water it will remain for a longer period about the level of discharge. Diffusion begins at once and is more rapid the less the salinity of the water. It probably bears some relation to the form of the jet, but at this stage it is of less importance than the mixing action due to currents. Where turbulent eddies occur mixing is rapid and the buoyant tendency due to the difference in specific gravity is obliterated. After this initial mixing further tendency toward putrefaction is usually deferred for at least several hours.

It was observed that when discharged into an equal mixture of sea and fresh water sewage rises from depths not exceeding 30 ft. so that it will probably be visible at the surface; but from depths of over 40 ft. it will probably not be seen unless discharged in very large volumes, although much depends upon the existence of subsurface currents.

A high salinity of the water retards diffusion. Streams of sewage are diffused more slowly in tidal waters than in rivers of fresh water. Moreover, salinity increases the upward tendency in submerged effluents so that they reach the surface more promptly and hence with less opportunity for diffusion. For these reasons and because the saponification of the soaps in sewage renders it more nearly opaque, because its capacity for dissolved oxygen is less and because any decomposition of sludge deposits gives rise to more offensive odors in salt water than fresh, the latter is generally a more favorable medium into which to discharge sewage.

The effluent from a submerged outlet in salt or brackish water rises to the surface in the form of a cone, spreads rapidly in a thin sheet so that at a moderate distance there is usually little evidence of pollution below a foot or two from the surface, although the line of demarcation of the sewage field may be quite definite for a considerable distance.

With a septic sewage, high temperature, and a stream low in dissolved oxygen, conditions favor putrefaction, and particular pains should be taken to secure rapid diffusion. The desirability of this is becoming recognized in the construction of submerged sewer outlets.

At Moon Island, 50,000,000 gallons of crude sewage from Boston is discharged near the surface on the first two hours of ebb tide. The sewage is dark, septic, foul in appearance and with a strongly offensive odor, although gross pollution is confined to the upper 5 ft. in depth of water. Discoloration of the water at times covers 1,000 acres, half of which may be called "offensive," and extends for a distance of over 1½ miles from the outlet.

A marked improvement is observed in the continuous discharge of 60,000,000 gallons per day off Deer Island from the North Metropolitan system. The discoloration is hardly noticeable below 2 ft. from the surface and little evidence of sewage is ordinarily found beyond a distance of 900 ft.

This marked improvement over the Moon Island outlet is attributable to the fresher condition of the sewage and its continuous discharge at correspondingly lower rates.

*From an article by Kenneth Allen, Engineer of Sewage Disposal, Board of Estimates and Apportionment of New York City, in the December Polytechnic.

But even here the sewage field may be detected as much as 1½ miles from the outlet under certain conditions.

The more recent two outlets from the South Metropolitan system near Peddocks Island, Boston, marked a further improvement in being placed at a depth of some 30 ft. of water at low tide. Here 53,000,000 gallons per day are discharged continuously, but there is no marked discoloration more than 30 ft. from the outlet.

The discharge of 67,000,000 gallons of the sewage of Washington from two outlets at a depth of about 28 ft. in the Potomac River is difficult to detect at the surface and the same may be said of that from the three outlets at Hamburg where 53,000,000 gallons per day enter the Elbe. In these examples there are the additional advantages of a discharge into fresh water, and in dividing up the flow between two or more outlets.

The Deer Island outlet in Boston Harbor is being extended 300 ft. into water 52 ft. deep at low tide. For about 240 ft. this is of 7-ft. cast-iron pipe converging to 4 ft. at the extreme end. The last 126 ft. is composed of lengths having openings near the middle and in the top directed forward by which the discharge will take place at 14 orifices including the end of the last pipe.

It has been proposed to construct outlets for the Passaic Valley sewer in New York Upper Bay, conical in shape, diverting upward and with a spiral flange on the inside for the purpose of delivering the sewage in the form of a thin, hollow cone. This, it was expected, would provide a large surface of contact with the bay water immediately after discharge.

Another feature of the Passaic Valley outlet is in providing multiple outlets. This has frequently been proposed in order to secure rapid diffusion, but has seldom been carried out. At Toronto, the outfall was carried out about 3,200 ft. from shore to a depth of 21 ft. The last 500 ft. was tapered from a diameter of 5 ft. to one of 2 ft. and perforated with 4-in. orifices 4 ft. 4 ins. apart.*

Another example of multiple outlets is in the new outfall at Cleveland where 70,000,000 gallons are discharged daily one-half mile from shore at a depth of 30 ft. from 6¾-in. holes, spaced 7½ ft. apart on each side of the tapered outlet pipe and 45° above the horizontal diameter.†

There is an advantage in a high velocity of discharge, but as this involves loss of head it cannot often be made use of unless the sewage is pumped. A horizontal is preferable to a vertical direction for the jet as it offers a greater opportunity for diffusion during the ascent to the surface, after which this proceeds more slowly.

At Copenhagen, to secure a similar result, there are provided two openings 6 ins. wide by 4 ft. long near the outer end of the new 43-in. wood stave outlet pipe, by which the upward discharge of 33,000,000 gallons per day will take place in the form of a thin sheet.

The area of pollution increases at a higher rate than the volume of discharge so that the interception of large volumes of sewage to a single outlet is unwise if the conditions are unfavorable for sufficient diffusion and dilution.

With so many factors involved it is impossible to formulate precise rules for the location and design of sewer outlets to secure prompt diffusion, but the principles to be followed are well known and may be summarized as follows:—

1. Locate the outlet in water: (*a*) as nearly fresh as possible, (*b*) as nearly saturated with oxygen as possible, (*c*) with the swiftest possible current, (*d*) at as great a depth as possible.

2. Discharge the sewage so as to secure as intimate a contact with the water on discharge as possible. This may be prompted by special orifices and by multiple outlets.

*As the flow, which is now about 55,000,000 U.S. gal. per day, caused a backing up by the increased friction, the outer 400 ft. of this outfall sewer have been removed.

†Another outlet of "Lock-Joint" concrete pipe is now under construction at Cleveland. This will be 84-in. in diameter for 2,400 ft. and then decreasing to 48-in. in another 1,000 ft. Also, at Lakewood, O., a similar outfall of 1,100 ft. of 36-in. pipe decreasing to 30-in. and 24-in. in the next 400 ft. has been laid to a depth of 20-ft. of water. Diffusion is promoted by 44-in. holes near the top of the pipe spaced about 7 ft. apart.

EFFECT OF MOUTHPIECES ON FLOW OF WATER

An elaborate series of tests was recently made by Fred B. Seely on the effect of mouthpieces on the flow of water through a submerged short pipe. These experiments were made with the advantage of the excellent hydraulic equipment of the Engineering Experiment Station of the University of Illinois, and the results have been issued as Bulletin No. 96 from the Station. The data are given in detail, and are reduced to mathematical expression, accompanied by tables and curves. The conclusions reached are the following:—

The preceding discussion has shown that the losses accompanying the flow of water depend largely upon the state of its motion, and this in turn is influenced by many factors, the effects of which often can be but roughly estimated. While the results of the experiments tend to define the range of such effects for certain conditions of flow, additional experiments would be necessary to establish all the inferences that have been suggested. The conclusions here given, however, seem justified:—

(*a*) As applying to conditions likely to be met in engineering practice, the value for the head lost at the entrance to an inward-projecting pipe, that is, without entrance mouthpiece and not flush with the wall of the reservoir, is 0.62 of the velocity-head in the pipe ($0.62 \frac{v^2}{2g}$) instead of $0.93 \frac{v^2}{2g}$, as usually assumed. To put it in another form, the coefficient of discharge for a submerged short pipe with an inward-projecting entrance is 0.785 instead of 0.72 as given in nearly all books on hydraulics. Further, the lost head at the entrance to a pipe having a flush or square entrance is 0.56 of the velocity-head in the pipe ($0.56 \frac{v^2}{2g}$) instead of $0.49 \frac{v^2}{2g}$ as usually assumed. In other words, the coefficient of discharge for a submerged short pipe with a flush entrance is 0.80 instead of 0.82, as given by nearly all authorities.

(*b*) The loss of head resulting from the flow of water through a submerged short pipe when a conical mouthpiece is attached to the entrance end, may be as low as 0.165 of the velocity-head in the pipe ($0.165 \frac{v^2}{2g}$) if the mouthpiece has a total angle of convergence between 30° and 60° and an area of ratio of end-sections between 1 to 2 and 1 to 4, or somewhat greater. In other words, the coefficient of discharge for a submerged short pipe with an entrance mouthpiece, as specified above, is 0.915.

(*c*) The loss of head which occurs when water flows through a submerged short pipe having an entrance mouthpiece varies but little with the angle of the mouthpiece if the total angle of convergence is between 20° and 90°, and if the area-ratio is between 1 to 2 and 1 to 4, or somewhat more. The loss of head for any mouthpiece

within this range would be approximately 0.20 of the velocity-head in the pipe (0.20 $\frac{v^2}{2g}$). There is, therefore, little advantage to be gained by making an entrance mouthpiece longer than that corresponding to an area-ratio of 1 to 2. Thus, an entrance mouthpiece, with a total angle of convergence of 90° and the length of which is only 0.2 of the diameter of the pipe, gives approximately 0.20 $\frac{v^2}{2g}$ for the loss of head.

(*d*) The amount of velocity-head recovered by a conical mouthpiece when attached to the discharge end of a submerged short pipe depends largely upon the angle of divergence of the mouthpiece, but comparatively little upon the length of the mouthpiece. This is true for lengths greater than that corresponding to an area-ratio of 1 to 2 and for total angles of divergence of 10° or more. The amount of velocity-head recovered decreases rather rapidly as the angle of divergence increases from a total angle of 10° to 40°. At or near 40° the amount of velocity-head recovered rather abruptly falls to approximately zero.

(*e*) A conical discharge mouthpiece, having a total angle of divergence of 10°, and an area-ratio of 1 to 2, when attached to a submerged short pipe, will recover 0.435 of the velocity-head in the pipe, which is 58% of the theoretical amount of recovery possible.

(*f*) The amount of velocity-head recovered by a diverging or discharge-mouthpiece, when attached to a submerged short pipe, is considerably more when a converging or entrance-mouthpiece is also attached than it is when the entrance end of the short pipe is simply inward-projecting; that is, with no mouthpiece attached. This excess in the velocity-head recovered diminishes rather rapidly as the angle of the discharge-mouthpiece increases, and it becomes zero for a discharge-mouthpiece having a total angle of divergence of approximately 40°. This increase in the velocity-head recovered is probably due to the effect of smooth flow in the pipe as the water approaches the discharge-mouthpiece. The smooth flow allows the mouthpiece to recover more of the velocity-head in the pipe than when a more turbulent flow exists; this increase amounts to as much as 33% in the case of the discharge-mouthpiece having a total angle of divergence of 10° and an area-ratio of 1 to 2.

While these conclusions are drawn from experiments on the flow of water through a particular short pipe having various entrance and discharge conditions, it is felt that the results of the experiments are applicable in a general way to a large variety of cases in engineering practice where the contraction and expansion of a stream of water occurs.

The deductions made are capable of use in connection with the loss of head which occurs when a stream contracts or expands under differing conditions of flow and they show the marked effect that turbulence of flow may have upon the amount of head lost, and they also have a direct bearing upon problems in hydraulic practice that involve the contraction and expansion of a stream in flowing through passages. Comparatively little experimental work has been done hitherto to determine the value of conical mouthpieces of various angles and lengths in reducing the lost head at the entrance to and discharge from a submerged pipe, particularly for mouthpieces of the sizes and proportions comparable with those met in engineering practice. The need for such experiments was apparent. The minimizing of the lost head due to the contraction and expansion of a stream may be of considerable importance in many hydraulic problems; for example, the intake of a pipe, particularly when the pipe is of short length and of large diameter, the suction and discharge-pipes of a low-head pump, the reduction or expansion from one pipe to another of different diameter or of different shape, the passages through a large valve, the passages through locomotive water-columns, the draft-tube to a turbine, the connection from a centrifugal pump to a main, the sluice-ways through dams, the slat-screens at head-gates, culverts, and short tunnels, jet-pumps, the Boyden diffuser as formerly used for the outward-flow turbine, the Venturi meter, the suction and discharge pipes of dredges, and the guide vanes and runner of a turbine. Losses due to this cause are difficult to estimate and easy to overlook. Even where such losses are in themselves of little consequence as compared with other quantities involved, they may have an important influence upon subsequent losses on account of the turbulent motion started by the contraction or expansion. The efficiency of a drainage-pump or other low-head pump, for example, may be increased by an entrance-mouthpiece on the suction-pipe because it allows the pump to receive the water in a smoother condition of flow. It is well known that a turbine must receive the water from the guide-vanes without shock if, in the subsequent flow through the runner, the energy of the water is to be absorbed efficiently by the turbine. The loss of head through a Venturi meter may be considerably increased if the meter is placed too short a distance downstream from a valve, elbow, or other obstruction or cause of disturbance in the pipe. The friction-factor for a pipe following an obstruction or bend may be changed by the disturbance thus caused; the lost head at the entrance to a pipe, particularly when projecting inward, may be more than that ordinarily assumed for a tube three diameters long. There is but little definite knowledge on the subject of the effect of abnormal conditions, and it offers a large scope for investigation. The fact that a comparatively small change in the form of the blades of a turbine-runner may result in a large effect on the efficiency of the turbine should prove suggestive when estimating the probable effect of turbulent flow in less severe or critical cases. It is also worth mentioning in this connection that the recent advances in turbine design have been due largely to the attention given to the approach-channels to the guide-vanes and to the design of the draft-tube.

The flow of water usual in engineering practice is rather turbulent. The general equation of energy, or Bernoulli's theorem, so generally used in hydraulics, applies only when the particles of water move with uniform velocity in parallel stream-lines. Although this condition of flow seldom occurs, satisfactory analyses may often be made by using an average velocity and introducing empirical constants. A very slight change in the conditions under which flow takes place may cause a large difference in the behavior of the water. There is always danger in extending the use of experimental data or empirical constants to apply to conditions of flow different from those under which the data were obtained.

Regular passenger train traffic over the new Quebec bridge has been inaugurated. The service was opened January 6th, when a train from Moncton used this route. Hereafter trains will leave the Union Station in Quebec City daily for Montreal and eastern points via the bridge.

Walter H. Morrison, an English engineer who has arrived in New York from Siam on his way home to England, says that the new railroad from Bangkok to Penang, in the Malay Straits, has just been completed, and will be open for passenger traffic next April. The distance of the new road is about 700 miles, and has been laid through tropical scenery.

THE MANUFACTURE OF RICHE GAS FROM WOOD IN THREE RIVERS, P.Q.

By L. H. Bacque, B.Sc.
Gas Engineer, Toronto

[NOTE.—"The Riché patents have expired," says Mr. Bacque, "and the process can be used by anyone." Mr. Bacque is well qualified to discuss the process as used in Three Rivers, as he built the Riché plant in that city in 1900, in co-operation with a French engineer, and managed it until 1909, when it was purchased by a newly organized natural gas company. The new owners, says Mr. Bacque, allowed the Riché plant to deteriorate, and after a fire, they did not rebuild it. The natural gas soon became exhausted and the company withdrew from Three Rivers, and since that time the city has had no public gas supply. Mr. Bacque does not advocate the Riché process for large cities, but he believes that it has merit for small town supplies, particularly in view of the increasing coal problems.—EDITOR.]

THE following notes on the manufacture of gas from wood in the city of Three Rivers, P.Q., by the Riché reinverted distillation process, will no doubt prove interesting to those who have had any doubts heretofore as to the possibility of making a commercial success of any manufactured gas other than that which is made from coal.

In the particular instance under consideration, the gas was made from wood because wood was both abundant and cheap; but it can be made equally readily out of almost any suitable organic matter and gathers additional interest from the fact that it can be readily manufactured from peats and lignites, both of which fuels the government is now studying with a view to finding some suitable industrial use for them.

Before attempting any comparisons, it will be well to go into the cost of manufacturing the gas from wood.

Originally, the builders gave the following guarantees with the plant, *viz.*: that 3 kilogs (6.6 lbs.) of air-dried wood, carrying not more than 25 per cent. humidity, would yield one cubic metre (35.3 cu. ft.) of 320 B.t.u. gas and a by-product of 270 grammes of charcoal; the gas to give the hour horse-power, measured on brakes, when used in a gas engine of good make.

This was practically equivalent to 1,000 cu. ft. of gas for $\frac{6.6 \times 1,000}{35.3}$ or 186.9 lbs. of wood costing $\frac{186.9 \times P}{2,000}$; where P is the cost of air dried wood, carrying not more than 25 per cent. humidity per ton of 2,000 lbs.

To get at the price of the gas, the value of the charcoal by-product, whatever it may be in the district, must also be deducted from the cost of the wood.

At a later date, the above guarantees were modified and expressed in terms more readily understood in Canada. They were:—

That 1,000 cu. ft. of 320 B.t.u. gas and a by-product of 18 lbs. charcoal would be produced by the distillation of 100 lbs. of air-dried wood, with 45 lbs. of coal as fuel.

Taking the conditions which existed in Three Rivers, where wood weighing 3,250 lbs. to the cord cost $6.50 per cord or $4 per ton of 2,000 lbs., and coal cost $4.50 per ton of 2,240 lbs., the cost price of the gas becomes:—

Cost of the wood, $\frac{100 \times 4.00}{2,000}$ or 20 cents.

Cost of the coal, $\frac{45 \times 4.50}{2,240}$ or 9.04 cents,

Or a total cost per 1,000 cu. ft. of 29.04 cents.

From this there is to be deducted the local value of the by-product of 18 lbs. of charcoal, which is:

$$\frac{18 \times Y}{2,000} \text{ or } \frac{9 \times Y}{1,000}$$

Y being the local value of same per ton of 2,000 lbs.

The above figures, it must be noted, represented the guarantees given by the builders, but much better results were usually obtained in actual practice, and notably in the plant built in Three Rivers, where the conditions were as follows:—

Cost of coal per ton (2,240 lbs.)	$ 4.50
Cost air-dried wood (25% hum.) per ton, 2,000 lbs.	4.00
Charcoal: 90% of product sold for (ton, 2,000 lbs.)	14.00
" 10% of product sold for (ton, 2,000 lbs.)	8.00

and the results actually obtained with the plant were: 1,000 cu. ft. of gas and 19.5 lbs. of charcoal for 90 lbs. of aid-dried wood and 39 lbs. of coal, which makes the cost of the gas figure out as follows:—

Cost of wood .... $\frac{90 \times 4.00}{2,000}$ or 18 cents per M.

Cost of coal .... $\frac{39 \times 4.50}{2,240}$ or 7.8 cents per M.

Or a total cost for wood and coal of.. 25.8 cents per M.

From this, there is to be deducted the value of the charcoal product, which is as follows:—

90% yields ..... $\frac{19.5 \times 90 \times 14.00}{100 \times 2,000}$ or 12.25 cts. per M.

10% yields ..... $\frac{19.5 \times 10 \times 8.00}{100 \times 2,000}$ or 0.78 cts. per M.

Total return for charcoal .... 13.03 cts. per M.

which, being deducted from the former figure of 25.8 cents, gives as the net cost of the gas, 12.77 cents per 1,000 cu. ft.

Now, to make a comparison of the relative cost of coal gas and Riché gas, let us take as a basis of comparison the yield per ton in gas and by-products of both wood and coal.

Taking the usual conditions prevailing in this market for coal gas where the average yield of gas is 10,000 cu. ft. per ton, of coke 1,300 lbs. per ton, of ammonia 5 lbs. per ton, and of tar 7 gals. per ton, the average return in gas and by-products from one ton of coal becomes:—

10,000 cu. ft. gas at $1.87½ per M.	$18.75
1,300 lbs. coke at $5 a ton	3.25
5 lbs. of ammonia at 6 cents a lb.	.30
7 gals. of tar at 3 cents a gal.	.21
Or a total yield per ton in cash of	$22.51

The cost price of this gas and of the by-products for fuel is:—

1 ton of coal	$4.50
500 lbs. of coke	1.25
	$5.75

leaving net profit on 10,000 ft. of gas, $16.76.

Making the same calculation for Riché wood gas, per ton of 2,000 lbs. wood, we get:—

Yield of gas per ton $\frac{2.000}{90}$ or 22,220 cu. ft.

Requiring in order to make them, 22,220 × 39 or 867 lbs. coal, making the cost of gas for fuel:—

Cost of wood distilled (2,000 lbs.) $4.00

Cost of coal burnt $\frac{867 \times 4.50}{2,240}$ 1.74

Or, for 22,220 cu. ft. $5.74

From this gas we get the following returns, on the basis of prices which existed in Three Rivers:—

22,220 ft. of gas at $1.00 per M. $22.22

Charcoal ...... $\frac{90 \times 14.00 \times 390}{100 \times 2,000}$ or 2.46

Charcoal ...... $\frac{10 \times 8.00 \times 390}{100 \times 2,000}$ or .17

$24.85

Deducting from which the cost of the gas for fuel, we have a net profit from the gas made from a ton of wood, $19.11

A comparison of the heat efficiency of both processes will reveal the fact that it is much greater in the case of the coal than in that of the wood. This is due to the fact that in the Riché wood process, a large amount of steam and hydro-carbons present in the wood absorb a large amount of the available heat for their transformation into fixed gases.

The fact remains, nevertheless, that the ton of wood yields 7,110,000 British thermal units available in the gas, whereas the ton of coal only produces 6,000,000.

Without going too deeply into minor details, it may be added that in Three Rivers, where conditions, though favorable in some cases, were otherwise costly enough to overcome in other respects the general expenses attaching to the manufacture and distribution of the gas were approximately as follows:—

	Cost per M. (Cents.)
Fuel for a make of 40,000 ft.	12.77
Labor for a make of 40,000 ft.	11.11
Maintenance retorts (labor and material)	10.92
Maintenance mains, etc.	6.85
Interest on capital invested	25.65
Sinking fund of 1 per cent.	5.13
Salaries, rents, etc., etc.	22.50
Cost of gas delivered to consumers	94.93

This price being established for gas made from wood, a comparison of the composition of lignites, peats and woods will bring out the striking similarity in the chemical composition of all three products, and make it easy for the lay mind to realize that the gas obtained from one of the products is the same as that obtained from the others, when treated by the same process.

The following table gives the average products obtained from each one of them by distillation, after they have been dessicated at a temperature of 200° C.:—

	Lignites.	Peats.	Woods.
Fixed carbon	39 %	30 %	22.3%
Gases by distillation	30	36	33.4
Tars	5	7.5	8
Acid liquids	15	14.5	33.6
Ash and sundries	11	10.5	2.7
Nitrogen	..	1.5	..
	100.0%	100.0%	100.0%

Now, taking the gaseous contents alone, shown in the above component parts, we get further evidence of the great similarity of the three products from the point of view of their gas-producing capacity. The following table, giving the per cent. composition of these gases by volume, makes this plain:—

Comparison by Volume of Gaseous Products of Distillation

	Lignites.	Peats.	Woods.
C_2H_4	4 %	2.5%	......
CH_4	19 %	7.0%	13.102%
HC vapors	1 %	1.5%	1.572%
H	31 %	40.0%	32.599%
CO	26 %	30.0%	23.794%
CO_2	15 %	14.0%	26.939%
Nit.-O, etc.	4 %	5.0%	1.994%
	100.0%	100.0%	100.000%

Now, taking as a sample, some Cardiff colliery lignite, for instance, carrying 20% humidity and 40% fixed carbon, in addition to its gaseous content, this sample will give exactly the same gas as product of its distillation by the reinverted process as wood does.

Approximately, also, the same quantity of lignite as of wood, will suffice to yield the 1,000 cu. ft. of gas, being in this instance about 150 lbs. instead of the 39 lbs. coal and 90 lbs. wood previously used.

This will give us $\frac{150 \times 1.50}{2,000}$ or 11.25 cents per M. as the cost price of the gas, where this lignite is worth $1.50 per ton of 2,000 lbs.

The value of the coke obtained will vary, of course, with the nature of the lignites used, but its value in any event will always be that of a good carbon fuel, which, figured on the basis of a price proportionate to that of the lignite for its own calorific value, will give us in this case $\frac{1.50 \times 15,000}{8,767}$ or $2.65 per ton of 2,000 lbs., if we allow 8,767 British thermal units as the heating value of the lignite and 15,000 as that of the coke made.

When distilling peats, it will not be possible to apply the reinverted distillation process in a single closed retort; it will become necessary to distil the material in one retort and send the products of distillation over red-hot carbon of some kind, which will have to be provided in a separate retort. This is due to the fact that the product of the carbonization of peat is simply a powder which will neither stand up sufficiently well in the retort nor allow the gases coming from the distillation to pass through it.

It is sincerely to be hoped that such a simple, cheap and convenient industrial application of three fuels so abundant in our country, will not be entirely overlooked, especially after recent developments in the coal business have revealed in such a striking manner how utterly dependent we are on our neighbor's good-will for our supplies of coal.

In a lecture entitled "The Economics of Bridge Design," Dr. J. A. L. Waddell, at the School of Engineering, Kansas University, said the question of what is the economic limit of length of simple-truss spans as compared with cantilevers is still a moot one. Professors Merriman and Jacoby place it in the neighborhood of 600 feet, but the speaker had occasion to compare simple-truss spans of 700 feet and 800 feet with the corresponding cantilever structures, and had found the former more economic. The continuity of cantilever spans in resisting wind loads lowers the requirements for minimum width from one-twentieth to about one-twenty-fifth of the greatest span length, and hence, because of substructure considerations, gives an advantage to the cantilever type that in certain extreme cases more than offsets its disadvantages of greater weight of truss metal.

Letters to the Editor

Erection of the Quebec Bridge

Sir,—In recent issues of your magazine I have noticed articles by Mr. A. J. Meyers, a member of the staff of the Board of Engineers, describing the erection equipment and centre span lifting devices used in connection with the erection of the Quebec Bridge, but note with regret that credit was not given to the St. Lawrence Bridge Company, who originated and developed the design and worked out the details for this equipment.

I would like to take this opportunity of stating that the plans for the superstructure and the entire plant and equipment used in connection with the erection of the bridge were worked out in the offices of the St. Lawrence Bridge Company, who, according to the terms of the contract, were entirely responsible for its successful completion, and great credit is due their engineers for the work they have done in this respect, since they had little or no precedent to guide them.

C. N. MONSARRAT,
Chairman and Chief Engineer,
Board of Engineers, Quebec Bridge.

Montreal, January 19th, 1918.

Provincial Consulting Engineering

Sir,—With reference to the editorial which appeared in *The Canadian Engineer* of December 13th, it must be clear to anyone who has read my report that the writer of the editorial does me an injustice. He selects one paragraph, interprets it wrongly, and proceeds to criticize that interpretation as if it were mine. I claim that I have been as anxious as the writer in *The Canadian Engineer* to defend the status of the engineer, and to demonstrate the need for a greater amount of use being made of his services in connection with municipal work in Canada. The report itself reflects that anxiety.

The employment of skilled engineering advice in connection with the planning and development of land instead of continued reliance on those who are not so skilled is advocated throughout the report. At the very beginning, on page 3, I put the scientific planning and development of land in the forefront of the points which need emphasis. That can only be attained if more engineering advice is sought.

On page 74, with regard to railways, I say that the detailed planning of railway lines "is a matter which is safe in the hands of the railway engineers who are entrusted with the work."

On page 155 I refer to the memorandum prepared by a number of well-known engineers on "Industrial Preparedness," and I selected that memorandum for reference out of a great deal of material on the same subject because it was prepared by engineers, and I state in the conclusion of the paragraph: "The memorandum very properly emphasizes that greater use should be made of the engineer and chemist, in whose hands is the material development of modern civilization."

There is a running argument throughout the whole of the report advocating the need for expert administration by engineers.

The paragraph to which your paper objects, is a recommendation made on page 238 arising out of the considerations put forward in Chapter VII. of the report. Turning first to that chapter, I draw your attention to the following quotation (page 180) referring to the need for business enterprise in connection with land development:—

"In the performance of such a task it is of the highest importance that the business side of the undertaking should be in skilled hands, that the control of all beginnings of development and of the utilization of resources should be under the direction of the highly qualified administrators."

It is obvious that this is an advocacy for the employment of more professional experts, engineers and others, to control development.

Referring to the English system of government, which places more reliance on permanent expert advice than in most countries, I say (page 180):—

"One result of this system is that an efficient permanent staff of expert administrators has grown up in the old country, in all classes of government, and matters of technical detail are dealt with more largely by experts."

This, again, is an advocacy of the employment of engineering experts to deal with engineering matters.

It will be observed on page 187 that the first fact which I use in support of improving the system of colonization and highway administration is a long quotation from a leading engineer and land surveyor in Saskatchewan, who wrote to me as a result of long experience, pointing out what he calls "the absurdity of the present system."

On page 188 I point out that the co-ordination of the different government departments is needed "so as to secure more efficient and scientific land development," and I go on to say that the planning of the provinces, on the whole, should be undertaken. How could this be done without much more use of consulting and municipal engineers than prevails at present?

In the last paragraph, on the same page, I suggest a Director of Surveys and a Director of Planning for each province, with a skilled staff to deal with all development. All this means placing more reliance on skilled engineering advice, which is the best way to raise the status of the profession.

The following paragraph, on page 196, is a direct recommendation that engineers should be more fully employed on municipal work:—

"In the rural districts and small towns, there is a tendency to try and manage the complicated and highly technical questions relating to township and town development by men without adequate knowledge or training for the task. Real economy is only possible where a full advantage is taken of skill and experience in carrying out constructive improvements and the work of developing land. It seems to be assumed that municipal affairs can be managed by lawyers, tailors, grocers, and others who, whatever their expert knowledge in their own business, have not—as a rule—the kind of experience and capacity necessary for municipal administration. A tailor who very naturally would not accept the advice of an engineer to cut cloth for a suit of clothes, will act as chairman of a public works committee of a town or village and direct complicated engineering construction requiring many years of special training to understand even its general details."

On page 201 I point out that, if the Federal Government are to take up the question of constructing highways, they should place the administration of road improvement "under an *expert board* instead of under a department of the government." Naturally, I had in mind a board of engineers, as only they would be expert in such a matter.

Far too small a portion of the engineering work in Canadian municipalities is dealt with by trained engineers, either as consultants or as resident engineers.

Municipal boards and provincial boards of health are chiefly appointed from members of the legal and medical professions, who "employ" engineers when they want engineering advice. Taking Ontario as an instance, there are few, if any, engineers holding administrative positions on boards dealing with engineering matters, such as the Railway and Municipal Board and the Provincial Board of Health. Why should engineers not be chosen to act to a greater extent on these bodies as they are in other countries? Why is it that engineers do not insist on representation on expert boards? When in Winnipeg, in 1916, I brought a proposal before the government that the Provincial Board of Health should make its sanitary engineer a member of the board. I have made the same suggestion on other occasions. Surely that was not slighting the engineer.

In the conclusion to Chapter VII., I contend that there should be a more scientific orgainzation of rural life and rural industries; that increased responsibility should be placed on expert permanent officials (i.e., engineers, etc.), and that departments of municipal affairs should be set up in each province with skilled advisers (i.e., engineers chiefly). It is a direct step from this chapter and its conclusions to the general recommendation which is made on pages 237 and 238, to which the editorial refers.

The point of the paragraph to which objection is taken may be summed up as follows:—

That there should be a skilled municipal department in each province, with greater reliance placed on engineers as expert advisers. How does this convey a "slight" on the consulting engineer? The writer of the article quotes the following phrase in a critical manner: "Until there is a skilled municipal department in each province, to advise and help local authorities with engineering advice, we cannot expect satisfactory improvement in the status of the municipal and sanitary engineer nor effective local administration of public works and sanitation."

The above phrase is immediately preceded, on page 241, by the following, which is *not quoted*:—

"Much of the work now being performed by the medical officer of health should be undertaken by the sanitary engineer. The medical officer has full scope for his skill and energy in fields which are essentially his own, and much of the municipal and sanitary engineering work he is doing is a burden of which he would rather be relieved, and which would be more efficiently performed by properly qualified engineering officers giving whole time service."

Is it a slight on the engineer to advocate that more engineers should be employed than at present, and that the status of the profession should be improved? *The Canadian Engineer* has itself devoted a large amount of attention to advocating these two things. I have said not one word nor made any hint that the work of consulting engineers employed in advisory capacities is defective.

In rural districts particularly, and even in many towns, no consulting engineer nor resident engineer is employed. I can quote many examples, but I will merely refer to one town of no less than 8,000 inhabitants within fifty miles of Toronto which has no resident engineer, and does most of its work through contractors directed by amateur committees without the aid of a consulting engineer.

I believe the taxpayers in that town think it is an economy to do without an engineer. Therefore, we have not only to face a situation which means that the citizens of that and hundreds of smaller towns lose largely because of want of engineering advice, but actually do so from the mistaken notion that the engineer is not worth his salary, and that engineering work can be done by anybody. Is it desired that this kind of real "slight" on the engineer should be continued? If so, then I admit I am rightly criticized for expressing my dissatisfaction with such a system.

Incidentally, I may mention two other matters regarding which I have expressed dissent in different parts of Canada. One is the employment of contractors in the double capacity of engineers and contractors, thus placing them in the position of being both employers and employed. In such cases the proper relationship of the contractor and engineer is reversed. The former is the "boss" and employs an engineering assistant to keep him right, whereas he should be doing his work under control of a consulting engineer. A second matter is the expensive habit in Canada of appointing legal arbitrators to determine purely engineering questions—a proceeding which has been largely abandoned in Great Britain, where great economy and efficiency is obtained by the employment of consulting engineers and surveyors as arbitrators. A single engineer can often determine a question which, according to the older method, would require a bench of lawyers, an array of counsel, and a number of expert witnesses. It is in such cases that the "slight" is given to the engineer.

The real objection of the writer seems to be to the proposal that expert departments of municipal affairs be created in each province, on the ground that this reflects on the consulting engineer, who at present is apparently presumed to do the work which would be undertaken by these departments. I have shown that he does not do the work, even in fairly large towns, and that he is not consulted properly, even on provincial boards. On page 197 I also point out that the small municipalities cannot afford to employ expert engineering advice, even if they desired to do so. I say:—

"In view of the enormous expenditure on municipal development it seems extraordinary that there is so little effort made to avoid the waste which results from lack of co-operation and from want of the knowledge which can only be derived from wide experience. Small municipalities, with scattered populations and few resources, have not the means to employ men of adequate skill and are compelled to undertake highly technical work without knowledge of mistakes or successes made by other municipalities. It is no excuse that these small and poor municipalities have inadequate means to employ experts or obtain knowledge; in so far as this lack of means exists the need should be met by the aid of the provincial governments. In view of the great issues and large expenditure involved it is of urgent importance to Canada that each province should have a well-organized municipal department with expert advisers on all kinds of municipal affairs. One of the special tasks of such a department would be to advise and assist small municipalities."

The intention in creating provincial departments of municipal affairs is primarily to secure the more extended employment of the engineer and the increase of his power as an official so that he can effectively apply his knowledge. Such extended employment is necessary to prevent "dishonest officialdom" from continuing evil practices.

In the final paragraph of the editorial there seems to be an objection to engineers serving except in an individual and competitive capacity. That is a point on which opinions among engineers may differ. Personally, I have seen the profession of consulting engineer become strengthened in the Old Country as a result of the more extensive use of the official engineer. Why should this

(Concluded on page 42, Construction News Section)

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Principal Contents of this Issue

THE PENALTY OF PARASITISM

It is pointed out in biology that certain living creatures have deprived themselves of any individual power of natural defence because they find borrowing too easy. Nature being inflexible in her laws, what is unused or otherwise provided for becomes atrophied; that in daily exercise thereby becomes strengthened. The penalty for disuse is merciless and certain inhibition.

We may not be such stuff as dreams are made of, but creatures of habit we certainly are and to escape penalty constant activity and struggle is the price exacted for continuous success.

The vice of imitation thus reacts upon its practitioner; it is impossible to imitate without suffering individual loss. Wrong thinking is in this respect of less moment than borrowed opinion. Individual thought is less easily led aside but is more amenable to reason because of the mental processes which led up to its conclusions.

To the credit of the trained man everywhere his desire is to originate, not to imitate, and this does not preclude him adding new ideas to his existing stock, but in the process it becomes absorbed and digested and when finally welded with existing idea it issues in a new form.

Obviously it is not the province of everyone to create but the habit of fundamental thinking is one to cultivate, and engineering training, by its insistence upon first principles, tends to this creative habit of mind. The attitude towards work thus engendered builds character and ultimately leads to new ideas. Even routine can be dignified and enlarged by reason of conscious study of reason.

Original thought pays large dividends, while parasitism atrophies he who follows so detrimental a course. There is need and room for more independent thought in every walk of life. It is useless to take over ready-made opinion or to follow without discrimination or reason a set formula or programme for which logic is refused.

Most general problems are as complex as those more directly technical, but the sinking of principle to expediency is not the province of an engineer nor does his training justify such a course. He must make selection from alternatives. This is granted, but he is swayed only by economic or other valid reason in his judgment.

The engineer may in his business be a pure materialist, dealing with objective problems, but in his diagnosis of this and the practical aspect of his work, though he is realist enough, these lead to a mentality flexible and comprehensive. This is a direct result of his training and work scarcely paralleled outside his own profession.

Above all, there are few parasites; to borrow is not easy, and his training rejects where close scrutiny is impossible.

MUNICIPAL WAR PROGRAMMES

The duties devolving upon our city authorities are onerous at all times, but particularly so during the war. The period of readjustment following the war will call for even greater executive ability. The greatest problem, after providing for the present needs of the people, is to arrange for the time when the soldiers will return and when they and the civilians now employed on munitions will be seeking other employment.

The British government has called upon all municipalities to consider this matter, and a large number of them have prepared or are now formulating programmes of public works.

It is a pleasure to note that some public authorities in Canada are organizing schemes of highway construction, but these will take care of but a fraction of the number of men who will be seeking work, and, besides, that class of work will not suit all men. That some authorities are moving, does not constitute a solution of the problem. All municipalities must sooner or later evolve methods of providing work of economic usefulness. Moreover, every well-organized commercial concern will also develop broad plans, or the social cataclysm induced by peace may be very unpleasant in many localities.

BRANCH MEMBERSHIP, CAN. SOC. C.E.

According to the report of council of the Canadian Society of Civil Engineers, the membership of the society's branches at December 31st, 1917, was as follows:—

	Members	Assoc. Members	Juniors	Students	Associates	Total
Calgary	40	9	5	1	1	56
Edmonton ...	11	30	7	9	—	57
Manitoba	38	90	27	22	—	177
Ottawa	64	120	38	22	2	246
Quebec	20	53	21	13	1	108
Saskatchewan .	10	50	4	5	—	69
Toronto	56	137	34	63	6	296
Vancouver ...	47	71	10	4	1	133
Victoria	26	39	9	2	—	76
	312	599	155	141	11	1,218

PERSONALS

V. C. Moynes, of the Toronto sales staff of the Canada Cement Co., Limited, has enlisted with the Royal Flying Corps.

G. J. Desbarats, Deputy Minister of Naval Service, has been appointed a member of an international board to settle outstanding questions between Canada and the United States respecting international fisheries.

Lieut. Alex. H. Carmichael, of Toronto, a student of Applied Science, class of 1918, has been appointed with his present rank to the 2nd Depot Battalion, 1st C.O.R. Lieut. Carmichael enlisted with the 180th Sportsmen's Battalion.

Major T. R. Loudon, B.A.Sc., in the class of 1904, and formerly a professor in the Faculty of Applied Science, University of Toronto, has been invalided home. Major Loudon went overseas with No. 1 Canadian Construction Battalion. Enlisting with the rank of lieutenant, he received his promotions while on active service, being given his majority in France with his original unit, which is now known as the 1st Canadian Railway Troops.

E. W. Gilman, general manager of the Canadian Ingersoll-Rand Co., Limited, was elected general manager of the Jenckes Machine Co., Limited, of Sherbrooke, P.Q., at a recent meeting of the board of directors of the latter company. The Jenckes company has been reorganized under the presidency of Mr. George Doubleday, of New York City, additional capital having been put into the business by men associated with the Ingersoll-Rand Co. New contracts have been secured which will necessitate the employment of several hundred more workmen.

CAN. SOC. C.E. MEETINGS

There were thirteen meetings of the Canadian Society of Civil Engineers at Montreal during the past year, with papers or addresses as follows:—

"Sheet Asphalt Pavements," by T. Linsey Crossley.

"Canada's Railway Problem and Its Solution," by W. F. Tye.

"Centre Street Bridge, Calgary, Alta.," by G. W. Craig and J. F. Greene.

"Pneumatic Caisson Work for the Foundations of the Petitcodiac River Bridge Piers at Moncton, N.B.," by E. M. Archibald.

"Some Studies on the Methods of Recovering Antimony from Its Ores by Volatilization Processes," by J. A. DeCew.

"Halifax Ocean Terminals," by A. C. Brown.

"Street Railway Negative Return System for the Mitigation of Electrolysis," by Dr. L. A. Herdt and E. G. Burr.

"Present and Possible Products from Canadian Woods," by Dr. J. S. Bates.

"Work on the Panama Canal," by Henry Goldmark.

"Motion Pictures of Munitions Manufacture in Canada," introduced by Brig.-Gen. Sir Alexander Bertram.

"Motion Pictures of Canada's Water Powers," introduced by J. B. Challies.

"The Quebec Bridge," by Lieut.-Col. C. N. Monsarrat.

"The Erection of the Superstructure of the Quebec Bridge," by Geo. F. Porter.

"The Quebec Bridge, Some Views of the Shop Work," by Phelps Johnson.

HONOR ROLL OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS

At the annual meeting of the Canadian Society of Civil Engineers, held this week in Montreal, there was unveiled an honor roll containing 859 names of members who had enlisted for overseas service for the duration of the war. The various classes of membership were represented as follows:—

Honorary Members	1
Members	87
Associate Members	373
Juniors	170
Students	225
Associates	3
Making a total of	859

Of these there have been killed in action or died of wounds:—

Members	5
Associate Members	28
Juniors	13
Students	12
In all	58

MEMBERSHIP, CAN. SOC. C.E.

The membership of the Canadian Society of Civil Engineers has been practically uniform since 1912. Starting in 1887 with a membership of three or four hundred, the total gradually grew until it passed the thousand mark in 1903. The period of maximum growth was between 1903 and 1912, two thousand new members joining in those nine years. Since 1912, the number has remained nearly stationary at about 3,000. The first thousand members joined in sixteen years, the second thousand in five years, the third thousand in four years, and then for the next five years the number was increased hardly at all, largely due to war conditions. The following table shows that about half of the members are in the grade of associate membership:—

	1915.	1916.	1917.
Honorary Members	8	8	10
Members	693	709	720
Associate Members	1,409	1,434	1,469
Associates	34	33	33
Juniors	357	376	361
Students	575	487	497
Total	3,076	3,047	3,090

ALBERTA DIVISION, CAN. SOC. C.E.

The Alberta Division of the Canadian Society of Civil Engineers held its annual meeting December 22nd, 1917, at which time the by-laws were approved and the following officers and executive committee for 1918 were elected:—

Chairman, Wm. Pearce, Calgary; secretary-treasurer, Samuel G. Porter, Calgary; executive committee, F. H. Peters, L. B. Elliott, Edmonton; J. T. Child, Banff; J. G. McGregor, Red Deer.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

The Fuels of Canada

Habitability of Certain Now Populated Sections of Canada Depends Upon the Efforts of Canadian Engineers in Bettering the Fuel Situation—Stirring Address at Annual Meeting of Canadian Society of Civil Engineers

By B. F. HAANEL, B.Sc.
Chief of Division of Fuels and Testing Department of Mines, Ottawa

IF the violent rupture of the peaceful conditions existing some four years ago had not occurred, it is very doubtful whether the subject of fuels would attract any special attention to-day, unless, perhaps, a discussion of such a subject disclosed new fields for profitable exploitation. To-day, however, the attention of the people of this country is forcibly centered on this very subject; because we are realizing, perhaps for the first time, our dependence, to so large an extent, on the United States for this essential commodity, and, further, are beginning to understand that our supply of fuels from that country may be cut off at any time.

In the past, and up to the present, we have been depending largely on fuels mined and prepared for the market by labor over which we have absolutely no control. As a consequence, we are at the mercy of foreign strikes and industrial disorganization, and either one or both of these are liable to occur.

A strike of coal miners, or a railroad strike in the United States would affect Canada more seriously in certain respects than the States, since in Canada we would not have the advantage of accumulated reserves which the United States would be certain to have in normal times.

But, there is even a more important factor which we must consider, *viz.*, the necessity which may occur for the United States to keep her fuels within her own country. Such a situation may not arise for some time, but the indications are that we may have to meet such an emergency in the near future.

Canada, to-day, is facing a fuel situation of great gravity; a situation which has not been created by any special conditions in this country, but by those obtaining in the neighboring country. The United States is suffering from a shortage of fuels as a result of the withdrawal of skilled labor from the coal mines to other occupations, and, perhaps more directly, to the abnormal demand on the transportation facilities of that country for the carrying of material directly connected with the conduct of the war.

We are not wholly dependent on the United States for our fuel supply, but we are dependent to the extent of 55 per cent. of our total coal requirements and 98½ per cent. of our crude and refined oil products. Large and important sections of Canada, moreover, are almost wholly dependent on imported coal for house-heating purposes. This is a matter for grave reflection, since in a country such as ours, where artificial heat must be supplied during eight months of the year for the sole purpose of maintaining life, a continuous and dependable supply of fuel is absolutely essential.

The fuel situation existing in Canada to-day is due to the ease with which fuels of all kinds, suitable for every requirement, were imported from the United States, and to the apathy displayed towards the exploitation of certain of our own fuel resources by the public at large.

We have not exploited our fuel resources, with the exception of wood, on an extravagant scale, but, on the contrary, we have been culpably neglectful of these vast stores of energy, insofar as we have failed to provide for the future by learning how to use our low-grade fuels, on which at no distant time we shall have to depend. The result of this neglect to improve our position and render ourselves independent, as far as possible, will be great suffering to the people of Canada, in the event of a stoppage of fuel supplies from the United States, if we do not, at once, take steps to render our own fuel resources available for our own needs.

The present unsatisfactory—indeed alarming—situation can only be improved by a determined and energetic exploitation and utilization of our own vast fuel resources.

I am prepared to show that Canada does possess abundant supplies of fuels, favorably situated, and that these can be exploited in such a manner as to render her much less dependent on, if not entirely independent of, foreign sources for her fuel supply.

Before enquiring into our fuel possibilities, it is necessary to state and analyze our annual fuel requirements.

Canada's Fuel Requirements

The total fuel requirements of this country during the year 1916 amounted to nearly 30,000,000 tons of coal; 299,426,121 Imperial gallons of crude and refined oil products, and firewood valued approximately at $60,000,000.

The railways burned 9,000,000 tons of bituminous coal; 7,000,000 tons were probably required for the purpose of generating power, and a large quantity was used for making retort or town gas, heating large buildings, and the manufacture of coke. Over 4,000,000 tons of anthracite were burned in domestic and other heating plants, and, to some extent, were used for industrial purposes. In normal times, practically the entire imports of anthracite coal are used for heating purposes.

Compared with her annual requirements, Canada's production of fuels for the same period amounted to 14,483,395 tons of bituminous coal, of which 2,135,359 tons were exported; 6,934,288 Imperial gallons of crude oil, and wood fuel to the value of $60,000,000. To meet our own needs, therefore, it was necessary to import 17,580,603 tons of coal, and 292,426,121 Imperial gallons of crude and refined oil products.

Of this quantity of oil, approximately 50,000,000 gallons were used on the railroads; 30,000,000 gallons for steamships, and the remainder, 210,000,000 gallons, was used for lighting and heating, in the form of kerosene and, to a large extent, in the form of gasolene, for power purposes.

This is a general statement of the extent of our dependency on the United States for these essential commodities.

An analysis of our fuel resources, their location and extent, will reveal the reason for the necessity of these excessive imports.

The Fuel Resources of Canada

The fuel resources of Canada exist in the vast coal fields of the extreme eastern and western portions of Canada; the lignite fields of the western provinces; the natural gas fields of Western Canada, and the province of Ontario; the petroleum fields of Ontario; the oil shales of New Brunswick, Nova Scotia, and elsewhere; the standing forests, and, last, but not by any means the least important, the great areas of peat bogs. This is a truly formidable array of resources. Now, let us enquire into their extent, quality, and location, since these are the most important factors concerning their exploitation.

The following is an estimate of the actual coal reserves of Canada, based on actual thickness and known extent. The location and approximate classification of the coals are also designated:—

Nova Scotia	2,137	million	tons of	bituminous coal.
	50	"	"	cannel coal.
Saskatchewan ..	2,412	"	"	lignite.
Alberta	382,500	"	"	lignite or sub-bituminous.
	1,197	"	"	low carbon bituminous coal
	2,026	"	"	anthracite and bituminous.
	669	"	"	semi-anthracite.
British Columbia	23,653	"	"	semi-anthracite & bituminous.
	118	"	"	low carbon bituminous coal.
	60	"	"	lignite.

In addition to these admittedly great reserves, we have in this country 37,000 square miles covered with peat bogs. The total estimated tonnage of fuel represented in this area is 28,000 million tons of 25 per cent. moisture peat fuel, equivalent, on the basis of actual heating value, to about 16,000 million tons of good coal. Of this total area, however, only a portion is favorably situated with respect to economic development. Twelve thousand square miles of peat bogs are distributed throughout the central provinces: Manitoba, Ontario, Quebec, and New Brunswick, and the estimated tonnage of peat in this area is 16,000 million tons, equivalent, on the basis of actual heating value, to 9,000 million tons of coal.

No estimate can be made of the forests of Canada which are available for firewood, and natural gas has a special value only in those districts which can be economically served with this fuel. Natural gas is of great value when it can be obtained in large quantities in well populated and industrial communities, but it possesses the disadvantage of being an uncertain source of heat.

Of petroleum, all that I shall say, at the present time, is that Canada is manifestly not a petroleum-producing country.

The principal fuel resources, then, which we have to consider are the bituminous and anthracite coals, the lignites, and peat. Oil shales and other sources of oils will be considered later.

The statement of the distribution of our fuel resources discloses the fact, that the true coals are situated in the extreme east and west, and the western part of Alberta; the lignite coals are situated in the provinces of Alberta and Saskatchewan, but lying between the limits of these deposits is a great stretch of territory devoid of coal measure of economic value. The 12,000 square miles of peat bogs are situated in this area.

The country naturally lends itself to a division into four parts or districts, and each district has an abundance of fuel peculiar to its own area. The first district embraces that portion of Western Canada which can be economically supplied with bituminous and anthracite coals; the second district, that area which can be supplied with lignite; the fourth area, that portion of Canada which can enjoy the full advantages of Nova Scotia coal. The third district cannot be economically supplied with any of the above coals. This area must either render itself independent of foreign fuel sources by developing and utilizing its excellent peat bogs, or remain, to a large extent, dependent on the United States. A large portion of the province of Ontario is principally affected in this manner.

To supply certain of these areas with fuel of the desired quantity and of a quality suitable for various purposes, constitutes a problem which must be satisfactorily solved before we can improve our fuel situation.

The bituminous coals of Canada are similar to those of the United States, and include large quantities of excellent coking coal. Their utilization for general industrial purposes presents no difficulties whatever, but for domestic purposes bituminous coal, in its raw state, is far inferior to anthracite, which is the fuel almost entirely used for these purposes in Canada. A most excellent fuel, practically the equal of anthracite, can, however, be produced from bituminous coal by a special process consisting of carbonization at low temperature and briquetting. This process is in actual operation to-day turning out briquettes of this description, entirely satisfactory for domestic purposes.

With lignite and peat, however, the situation is totally different. In their raw state, peat and a large portion of the lignite are not suitable for use. These fuels must be submitted to some preliminary treatment before they can be utilized for general fuel purposes.

When the peat deposits of the central provinces, and the lignites of Saskatchewan and Alberta are rendered into forms convenient and suitable for domestic and industrial purposes, the fuel situation, so far as Canada is concerned, will have been greatly improved.

Before treating these two fuels in detail, it is necessary to draw your attention to the fact that the transcontinental railways traversing the western provinces are prohibited by an order of the Railway Commission from burning lignite in the locomotives during the summer months. These railways, on their west-bound trips, are consequently compelled to burn imported coal to that point in the western coal fields where they can again replenish their tenders with native bituminous coal. The same thing takes place on that portion of the eastbound trip traversing the province of Ontario.

Apart from this order issued by the Railway Commission, the railways would much prefer to haul and burn imported coal, inasmuch as lignites—at least certain of them—are not suitable for locomotive use.

The railways of Ontario also are entirely dependent on imported coal.

Preparation of Lignite and Peat for Economic Utilization

The utilization of certain of the lignites for some purposes is possible without any subsequent treatment. With others, however, notably those of Saskatchewan, the lignites as mined are not suitable for use. This is due to the physical and chemical properties peculiar to this type of fuel.

Lignites usually contain large quantities of moisture, ranging from 16 to 35 per cent. of the weight of the fuel, and the evaporation of this moisture, whether by natural or artificial agencies, results in the disintegration of the fuel. This disintegration, however, does not discontinue when the evaporation of the moisture is complete, but appears to go on indefinitely.

One more peculiarity must be mentioned, *viz.*, the dangerous sparks emitted from the stacks of locomotives when lignite is burned. These sparks, when they emerge from the stack, burn with a small flame and this flame is not extinguished by its passage through the air, as is the case with bituminous coal or anthracite coal sparks, but continues to burn after lighting on the ground. On account of this dangerous property, lignites cannot be safely burned in locomotives.

Lignite, unlike the true coals—bituminous and anthracite—lacks definite structure. (This term is employed in its physical sense.) To this may be attributed the reason for the difficulty with which lignites submit to mechanical treatment.

The characteristics of lignites must be altered before they can be converted into a satisfactory fuel. Experiments on a commercial scale have demonstrated beyond doubt the fact that our lignites cannot be briquetted in the raw state with or without the addition of a binder. Briquettes made in this manner appear, on casual examination, to be entirely satisfactory, but when submitted to a water test, or when burned, they will invariably disintegrate.

The characteristics of a lignite are changed by carbonizing it at low temperature. During this process, the moisture and volatile matter are completely distilled off, and there remains in the retort a residue composed of practically pure carbon. This residue is then mixed with a suitable binder, and briquetted. In order to render this briquette waterproof, a second heat treatment, or baking, is necessary. A fuel entirely satisfactory in every way, waterproof, capable of resisting disintegration when exposed to the weather, standing rough handling without breaking, not emitting flaming sparks, and capable of maintaining its physical structure or shape under the action of heat until completely consumed, has been produced by such a process. In order to demonstrate that this process will solve the problem in connection with our western lignites, it is advisable to erect a commercial plant capable of producing one or two hundred tons of lignite briquettes per day. Such a plant would have to be equipped in such a manner as to allow of a certain amount of experimental work being performed, *e.g.*, in connection with binders.

I am of the opinion that it would require only a comparatively small amount of money, *i.e.*, compared with the immense value which the solution of this vitally important problem would be to the country—to successfully demonstrate that the lignites of the west could, by means of such a process, be converted into a fuel entirely satisfactory for domestic and industrial purposes.

The establishment of briquetting plants at strategic points throughout the lignite provinces of the west would very greatly help in reducing our dependency for fuels on other sources. While a domestic fuel is, of course, of first importance, lignite briquetting industries would prove also of great value to the railways traversing the lignite belts. It would even be within the realm of possibility to economically supply at least a portion of the province of Ontario with this class of fuel.

The only remaining low-grade fuel to consider is peat.

Peat Fuel

The exploitation of our peat resources for the manufacture of a fuel does not involve any research work or experimentation. An economic process for the manufacture of raw peat into an excellent fuel suitable for domestic and, to some extent, industrial purposes, is in use to-day, and has been employed for many years in the peat-using countries of Europe. There is a flourishing and extensive peat industry in several of the European countries, but, in Canada, a country possessed of magnificent peat resources, and dependent to so large an extent on foreign supplies of coal, no peat industry exists. This deplorable state of affairs is due to misdirected energy in connection with the many attempts made to manufacture a fuel from peat, and to a general lack of interest towards anything connected with "peat" by the influential men of Canada.

Whether or not a particular natural substance shall be exploited has usually been decided from a "profit" point of view. Peat, not holding out great prospects for fabulous profits, failed to attract the attention of the large capitalists and industrial men. The creation of a peat industry was, therefore, left to the mercy of a few earnest and honest men with insufficient capital to prosecute an undertaking of this kind to a successful issue, and to a few fakirs and otherwise unscrupulous promoters, whose sole aim and purpose was "to get away with the money" before being discovered. Without going into detail, it will suffice to say, that several attempts have been made and as many failures with loss of capital involved have been recorded; but the larger portion of the capital lost could have been saved and a flourishing peat industry long ago established, if the promoters had been advised by accredited engineers who understood their business. Instead, however, of profiting by the experience of European investigators—gained at great expense—money was expended in developing and trying out ideas which had long before been discarded as impracticable, and, in many cases, impossible, by the investigators and engineers of the peat-using countries of Europe. Not until the results of the investigations conducted by the Mines Branch of the Department of Mines concerning the economic methods employed for the manufacture of peat fuel in European countries were placed at the disposal of the public, were men with impractical ideas dissuaded from interesting people in their schemes. Men of this description are still found going from place to place in a vain endeavor to interest capital, but they are rapidly disappearing.

Not until the utilization of a natural substance is forced by absolute necessity, will the most sincere and earnest efforts be put forth to successfully and economically convert it into a usable product. It appears to me that the time is at hand when necessity will decide that we Canadians utilize our peat resources, and in the most efficient manner.

Peat, in its natural state, is generally associated with about nine times its weight of water. It is, therefore,

evident that 1,800 pounds of water must be removed in order to recover 200 lbs. of solid matter. Moreover, this solid matter not only represents the combustible substance, but also the ash and mineral matter which is associated with the peat.

The separation of this large quantity of water, and the handling of so large a quantity of raw peat substance, in order to obtain a comparatively small quantity of combustible matter, represent the difficulties with which we are confronted when an attempt is made to manufacture peat into a fuel, on a commercial basis, and in a thoroughly economic manner.

The only economic process in existence to-day is that which employs the forces of Nature—the sun and the wind—for the removal of the moisture. The process employing these forces is called the "wet process," and the product obtained is termed "machine peat." This is the process which the Mines Branch, Department of Mines, demonstrated at the government peat plant at Alfred, Ont.

We not only have the process for manufacturing peat fuel, but also sufficient detailed information concerning peat bogs of immediate importance, to make a good start in the formation of a peat industry.

During the period covering the past ten years, the Mines Branch has completely investigated and mapped 58 Canadian bogs, all of which are situated conveniently with respect to inhabited and industrial communities, and also well situated with respect to railway and other transportation facilities. The investigations are conducted with a view to determining the principal and controlling characteristics of a bog, *viz.*, its area, depth, quality at different depths, quantity in tons, and, in general, its suitability for any particular purpose. The area examined in detail comprises 170,000 acres, and represents a quantity of standard peat fuel, *i.e.*, fuel containing 25 per cent. moisture, estimated at 120,000,000 tons. Seven bogs conveniently situated with respect to Toronto could supply that city with 26,500,000 tons of fuel, and seven bogs in easy reach of Montreal could supply 23,500,000 tons of fuel. Excellent bogs are, likewise, conveniently situated with respect to thickly inhabited communities, in Nova Scotia, New Brunswick, and other parts of Canada. This completes our inventory of the solid fuels. In regard to oil, we are not so favorably situated.

Sources of Oil

The oil fields of Ontario, the oil shales of New Brunswick, Nova Scotia and elsewhere and the bituminous coals and lignites constitute the only economic sources of oil known to exist at the present time. Energetic and intelligent prospecting directed by able petroleum geologists may disclose new oil fields of economic importance. This, however, must be accomplished before the above statement of our oil resources can be modified.

The productivity of the oil fields of Ontario is decreasing at so rapid a rate that it will be comparatively only a short time before they will cease to be a source of oil.

The oil shales of New Brunswick and Nova Scotia are, on the other hand, a most valuable source of oil. They are of large extent and rich in oil. The average oil content of a large number of samples representing various portions of the New Brunswick shale deposits is from 35 to 40 Imperial gallons per ton and if these samples are representative of the entire deposits, the total quantity of oil contained in these shales is very large.

Our bituminous coals and lignites also may become important sources of oil. The yields of benzol and tar from one ton of bituminous coal when coked in a by-product recovery oven are respectively 1½ and 5 gallons. The maximum yield of oil which might be expected when lignites are distilled solely for this purpose is probably not more than 3 per cent. of the weight of the fuel distilled. This figure may be subject to change; but the results of the work so far completed by the Mines Branch in connection with an investigation concerning the value of lignites as a source of oil do not indicate that a higher yield can be expected.

The total quantity of coal coked in Canada during 1915 was 1,856,393 tons, and if this quantity were coked in by-product coke ovens the yields of benzol and tar would be 2,800,000 and 9,000,000 gallons respectively. This yield of benzol could be further increased by distilling the tar recovered. The maximum quantity of benzol which could be recovered from the above quantity of coal is about 3,712,786 gallons.

The yield of light and heavy oils from 1 ton of bituminous coal is considerably increased when this coal is carbonized at low temperature.

Our oil requirements, as stated before, were, in 1916, nearly 300,000,000 Imperial gallons, while our domestic production was less than 7,000,000 gallons. A small quantity of benzol also was recovered in the by-product coke ovens operated during that year. In order, therefore, to produce sufficient oil to equal our imports of this commodity, we would have to distil an enormous quantity of coal and lignite, or oil shales, or both. The production of 300,000,000 gallons of oil from lignite would necessitate the distillation of about 30,000,000 tons of this fuel. This is manifestly impracticable.

As far as the oil shales are concerned, their distillation on a very large scale is not only entirely practicable, but very desirable. Large plants for the distillation of oil shale are in continuous operation in Scotland, and such plants were in operation in France prior to the war. Our shales are in no sense inferior to those of Scotland and could be exploited as easily and as profitably. No sound reason, therefore, exists for allowing this valuable source of oil to lie undeveloped.

Our domestic production of oil cannot be increased without great effort and the expenditure of considerable money, but provision must be made, and immediately, to provide against the time, not far distant, when the United States will be compelled to cease exporting her crude and refined oil products.

This will be forcibly brought into evidence by the following statement regarding the present status and future outlook of the oil industry in the United States. The production of oil, from 1859 to the year 1915, was 3,616,561,244 barrels, of 43 gallons to the barrel, and the possible future production is estimated at 7,629,000,000 barrels. This estimate was prepared for Senate Document 310, and was made by 30 prominent petroleum geologists of the United States Geological Survey. The United States, up to the year 1915, had exhausted 32 per cent. of her possible petroleum resources. If the present annual production is maintained, but not increased, her total crude oil supplies will be exhausted in less than 30 years. But, if the present rate of increase of production is maintained, total exhaustion will occur in a much shorter time.

It is apparent, then, that we will not be allowed to enjoy the advantages of the oil resources of the United States for a great while longer.

We can scarcely hope, for some time to come, to produce oil on a scale comparable with our demands—but we can appreciably reduce the quantity which must be imported and when oil can no longer be imported we will

simply have to reduce our requirements or else find a substitute.

Our total oil production from all sources might probably be increased to 120,000,000 gallons; by erecting oil shale distillation plants in New Brunswick with a combined capacity of 100,000,000 gallons and by increasing the quantity of coal coked in by-product ovens or by carbonizing large quantities of bituminous coal at low temperature and briquetting the carbonized residue.

The low temperature carbonization and briquetting of Nova Scotia coal either in Nova Scotia or at some centre of distribution favorably situated with respect to water transportation, as Montreal for example, would not only appreciably increase our production of oils, but would also be the means of supplying, for domestic purposes, a coal equal in many respects to anthracite. The fuel situation of some parts, at least, of Ontario might, in this manner, be much improved.

If this idea were carried out, our oil production would be:—

	Gallons
From oil shales	100,000,000
" coke ovens and low temp. carbonization	14,000,000
" Ontario petroleum fields	6,000,000
	120,000,000

This completes the survey of our fuel resources and our fuel situation as it exists to-day. The fuel situation of the future will depend on the efforts we make to render our own fuel supplies available for utilization by the people.

Economic Utilization of Our Fuels

I desire now to deal with the methods to be employed for the utilization of fuels in general, in order to convert the maximum of their heat energy into usable forms of energy, and to recover the maximum of the valuable chemical compounds which can be obtained from the solid fuels.

All of the solid fuels contain the element nitrogen, some to a very large extent, and this is the basic element of a most important chemical compound—ammonium sulphate. In normal times this substance is used very extensively for agricultural purposes, in order to restore to the exhausted wheat fields and other agricultural lands the essential nitrogen which has been removed, almost to exhaustion in certain instances, by the repeated raising of the same crops.

The necessity for employing such a fertilizer on our western wheat fields may not be apparent to everyone, because of the large increase in our wheat production reported from year to year. This is directly due to the large crops realized from the new virgin fields which are put under cultivation each year. The average yield per acre of the older wheat fields, however, is rapidly decreasing, and if their production is to be maintained or increased an artificial fertilizer will have to be employed.

This fertilizer is, however, in great demand in other countries, and its recovery in Canada and sale to other countries would, in many cases, prove to be a profitable venture.

The solid fuels are burned on a large and continually increasing scale for the production of power, town or retort gas, for the manufacture of metallurgical coke, and for general heating purposes.

The employment of the by-product recovery coke oven for the manufacture of metallurgical coke is taking place on a large and rapidly increasing scale in the United States, and Canada is now employing such ovens to a considerable extent. The manufacture of coke in by-product ovens is attended with the recovery of ammonia and the oils previously referred to. The entire quantity of coal used for coke and gas making should be utilized according to this method.

Power, other than hydro-electric, can be produced from the solid fuels in two principal ways: through the media of, first, the steam generator, and steam engine; second, the gas producer and gas engine.

When the energy of coal is converted into useful work by the first method, all valuable by-products are forever lost. When the second method is employed, and the producer is of the by-product-recovery type, it is possible to realize a maximum recovery of the nitrogen content of the fuel. The thermal efficiency obtainable with the latter is also considerably higher than can be realized with the steam power plant.

The producer gas by-product recovery plant is eminently suitable for the production of a power and industrial gas, and the field of its application might be extended to include the supply of gas for certain domestic purposes, *e.g.*, general heating. Such a gas possesses the advantage of low cost, inasmuch as the plant can be situated at or near the source of fuel. Moreover, the cost of operating the plant can be appreciably reduced through the sale of the by-products and this results in a further reduction of the cost of the gas per 1,000 cu. ft., if the production of gas is the main purpose.

We, however, possess sources of fuels especially high in nitrogen, *viz.*, the peat bogs. The average nitrogen content of all the peat bogs so far examined is high—but there are a few notable peat bogs of large extent, containing fuel of excellent quality, in which the nitrogen content is very high. The fuel of such bogs should unquestionably be utilized in by-product recovery producer gas plants, for the production of power or a power, industrial, and domestic gas. The bogs referred to and described in detail in Mines Branch Report 299, are favorably situated with regard to populated communities and industrial centres.

Some of our fuels are especially valuable for purposes for which no other fuel can be substituted. This is especially the case in the coking variety of bituminous coals, and these fuels, at the present time, are being used indiscriminately for all purposes, notwithstanding the fact that the coking coals are invaluable for many metallurgical purposes and cannot be replaced, by any means known to-day, with non-coking coal. A coking coal should, therefore, never be used for any purpose for which a non-coking coal will be entirely suitable.

The quantity of coke produced in Canada to-day is small, and the necessity for conserving this class of coal may not be apparent. The great demand, however, for metallurgical coke in the United States and the probable depletion in the not far distant future of the supplies of this fuel in that country will, in time, make our deposits of coking coal of special value. When that time arrives, we shall have an excellent commodity for purposes of barter, if we now take steps to conserve our supplies.

The problems associated with the distribution of fuel to the various parts of Canada are somewhat complicated, owing to the distribution of its population. In order to supply heat and power in the most economical manner and at the lowest cost to a population so widely scattered, the most rigid economy must be installed. The added cost to a fuel consequent on large rail haulage and local distribution can be very materially reduced by centralizing heating and power plants.

The populated sections of the country should be carefully studied with a view to its logical division into sections, each of which could be economically supplied with heat and power by one central heating or power plant. If this were carefully followed out, very marked economy would result in both the use of the fuel and its cost to consumer. The difficulties entailed in the distribution of the required fuel for such communities would, at the same time, be very largely overcome.

Many of our industrial plants have been located without any regard to the source of power or fuel on which they depend. Such industries, wherever it is possible to do so, should be moved to a locality which can be economically served with hydro-electric energy or electric energy generated in a large central plant, and industrial sites in general should be set aside for the location of all future industries.

It is evident that our fuels cannot be used indiscriminately and without the exercise of some degree of intelligence. We must not only meet all our own fuel requirements and place the people of this country in such position that they will not need to worry about a possible coal famine, but we must, at the same time, utilize our fuels in the most advantageous and economic manner. Great as our fuel resources are, we must practise conservation. Only by doing this do nations become strong and powerful.

The fuel situation of Canada, as I view it, is not a gloomy or discouraging one, for we are endowed with fuel deposits on a magnificent scale. All that is necessary now is that their proper exploitation and economic use be assured.

It will, therefore, be the duty of the engineering societies represented by your society and others to produce the necessary and unremitting pressure upon the proper authorities to give effect to your recommendations for the betterment of our fuel situation, so that Canada may be, for years to come, relieved from the ever-recurring anxiety of where the next year's fuel supply is to come from.

You can readily understand that the task before you, as engineers, is a difficult one, but one of the greatest possible importance, for the habitability of certain now populated sections of Canada depend upon the success of your efforts.

Abstracts from Branch Reports, Can. Soc. C. E.

OTTAWA

ALTHOUGH war conditions have vitally affected the activities of the Ottawa branch, the past year has been a very successful one. The strictest economy has been practised. We are still without permanent quarters, and as a result, the branch has a surplus of approximately $1,200.

There have been many changes in our membership during 1917, due largely to the movement of engineers employed in the various government departments. The membership now totals 272, of whom about 63 are now on active service.

There has been a large and representative attendance at all of our regular meetings. The following is a list of the meetings during the year:—

Evening Meetings: February 15th, "Light vs. Illumination," J. W. Loomis; March 9th, "Front Line Communications," Major T. E. Powers; March 15th, "Storage Dams on Ottawa and St. Lawrence," C. R. Coutlee; April 12th, "Municipal Engineering," A. F. Macallum; May 10th, "141st Meridian," J. D. Craig; September 7th, "Optic and Acoustic Principles of Lighthouse and Fog Alarm Apparatus," Lieut.-Col. W. P. Anderson and F. P. Jennings; October 20th, "Mechanical Filtration," H. L. Seymour; November 29th, "Geology as Applied to Civil Engineering," W. J. Dick; December 13th, "Coal Gas," F. Elcock; December 20th, "Quebec Bridge," Lieut.-Col. C. N. Monsarrat.

Luncheon Meetings: February 1st, "Some of the Ways in Which the Engineer May Assist in the Development of Canada," Col. J. S. Dennis; March 1st, "Agriculture and the Engineer," Hon Martin Burrell; March 29th, "The Present Status of the Engineer in Canada," W. F. Tye; April 26th, "Manufacture of Munitions as a Permanent Asset to Canadian Industry," Col. D. Carnegie; October 20th, "Mechanical Filtration," H. L. Seymour; November 15th, "The Awakening Recognition of the Engineer," F. S. Keith.

During the year the managing committee appointed an official librarian to be responsible for the books and records of the branch. The librarian is collecting and maintaining a complete set of government publications appurtenant to engineering. A special effort has been made to secure appropriate contributions from members of the society. Special reference in this connection should be made to a valuable donation from Sir John Kennedy, for which the Ottawa Branch is very grateful.

The annual meeting of the branch was held January 11th, when the following officers and members of the managing committee were elected:—

Chairman, G. Gordon Gale; secretary-treasurer, J. B. Challies; managing committee, S. J. Fortin, J. H. McLaren, W. F. M. Bryce, W. J. Dick and E. B. Post.

QUEBEC

AT the annual meeting of branch, held January 14th, the following officers were elected: Chairman, A. E. Doucet; secretary-treasurer, W. Lefebvre; members of committee, Alexander Fraser, J. E. Gibault and A. B. Normandin.

The branch had six meetings during the year, which were fairly well attended. The uppermost subject at most of the meetings was that of the betterment of the engineering profession, it being held of vital importance to the society that any person seeking admission should have the proper qualifications, and that, insofar as the province of Quebec is concerned, no admission should be made except in strict accordance with the terms of the provincial charter. In the opinion of the members of the Quebec Branch it is most desirable that a list of schools of engineering recognized by the council of the society should be prepared and sent out to the branches.

During the course of the year the following lectures were given:—

"Making and Filling of Shrapnel Shells," by Martin M. Wolff; "Report of the Proposed Amendments to the By-laws to be Submitted to the Provincial Government,"

by A. R. Decary; "The Flooding of the Chaudiere River on the 31st July, 1917," by A. E. Evans.

The financial standing of the branch is satisfactory owing to strict economy practised and largely due to the kindness of the mayor of Quebec in placing a convenient room in the city hall at the exclusive disposal of the branch members.

The membership of the branch totals 108.

TORONTO

THE Toronto Branch, notwithstanding the fact that 33⅓ per cent. of the membership are on active service, had a successful year. The executive committee held 20 meetings. In addition to this, 8 open meetings were held at which the following papers were presented:—

"Labrador Revisited," Prof. A. P. Coleman; "The Work of the Canadian Engineer at the Front," Capt. Mathieson; "Venezuela and the Islands of the Caribbean Sea," H. K. Wicksteed; motion pictures, the water-powers of Canada.

The membership of the branch totals 316.

During the year a committee was elected to draft by-laws for the branch and study means for increasing the prestige and influence of the branch. By-laws have been adopted in consequence of this committee's work.

A committee on roads and pavements has presented a report on their activities.

The report of the library committee made special mention of gifts from Sir John Kennedy and the Ottawa Branch, which were much appreciated.

At the annual meeting held January 15th, the following officers were elected:—

Chairman, Prof. Peter Gillespie; secretary-treasurer, Geo. Hogarth; executive committee, J. R. W. Ambrose, Willis Chipman, E. L. Cousins, Prof. Haultain, E. G. Hewson and R. O. Wynne-Roberts. The retiring chairman, E. W. Oliver, also acts as a member of the executive.

MANITOBA

ELEVEN regular meetings of the branch were held, at which the following papers were read and discussed: January 4, "Scientific and Industrial Research," E. Brydone-Jack; February 2, "A View of Necessary Action for After-the-War Conditions," T. R. Deacon; March 1, "Methods Adopted in the Construction and Ventilation of Connaught Tunnel," J. G. Sullivan; April 5, "Contracts 32, 33 and 34 of the Winnipeg Aqueduct," Wm. Smaill; May 3, "Subsurface Formation of the Winnipeg District and Types of Suitable and Unsuitable Foundations for Its Heavy Buildings," J. G. Rankin; October 4, "Drainage in the Red River Valley in Manitoba," G. B. McColl; October 18, "A Civic Duty for Engineers," F. A. Cambridge; November 1, "The Fixation of Atmospheric Nitrogen," V. J. Melsted; November 19, "Some Elements of Economy in Air Compressors," Wm. Carter; December 6, "Munitions," J. Chalmers; December 18, "Lignite Coal as Applied to Modern Steam Plants," T. L. Roberts. The average attendance at these meetings was 27.

Meetings were also held by the Electrical Section during the first part of the year (1917) as follows: January 10, "Train Lighting System," A. C. Turtle; February 14, "Progress in the Electrification of Steam Railways," W. A. Duff; March 21, "The Mercury Arc at Constant Pressure," J. W. Dorsey; April 11, "Electric Furnaces," A. M. Tirbutt; May 9, "Automatic Printing Telegraph," H. McConkey.

At the beginning of the season 1917-18 it was decided to discontinue the activities of the Electrical Section for the present and to hold two meetings of the branch each month, the second monthly meeting to be held on the third Monday of the month.

In addition to the regular meetings, members of the branch were the guests of the Greater Winnipeg Water District on July 21st in an excursion over the work on the aqueduct.

On September 13th a motion picture exhibit of water powers throughout Canada, prepared by the Dominion Water Power Branch of the Department of the Interior and loaned to the society, was held under the auspices of the Manitoba Branch in Kelvin Technical School.

On September 20th, members were the guests of the Canada Lock Joint Pipe Co. in an inspection of the work being done by that company, at Transcona, for the Greater Winnipeg Water District. Luncheon was provided by the company at Transcona and a special train was furnished by the Water District for the trip.

The branch had the pleasure, on August 15th and 16th, of entertaining our new secretary on his first official visit to the branches. Mr. Keith met many members at luncheon on the 15th and later visited points of engineering interest in the city and vicinity.

This first visit of the secretary was much appreciated and a unanimous resolution was forwarded to the council recommending that the visit of the secretary to the branches be made an annual event.

Four applications for admission as local associates were favorably passed by the executive. The membership of the branch now includes 37 members, 85 associate members, 26 juniors, 22 students, and 43 local associates, total 202.

Fifty-nine members of the branch have enlisted for active military service. Four have been killed in action or died of wounds.

The death, on February 6th, of W. L. MacKenzie, chairman-elect and one of the oldest and most valued members, was a great loss to the branch.

W. A. Duff was elected chairman to fill the vacancy caused by the death of W. L. MacKenzie.

The annual meeting of the branch was held December 6th, 1917, and the following officers were elected for the season 1918-19: Chairman, W. A. Duff; secretary-treasurer, G. L. Guy; executive committee, W. P. Brereton, J. C. Holden, W. M. Scott; auditors, B. S. McKenzie, T. L. Roberts.

The treasurer's report presented at the annual meeting of the branch showed a credit balance of $742.94.

SASKATCHEWAN

THIS is the first annual report of the Saskatchewan Branch, Canadian Society of Civil Engineers, a continuation of the Regina Branch which was founded in January, 1915, and which concluded its first year with 25 members. Our last annual report (as Regina Branch) dated January 19th, 1917, shows a membership of 30, of which 11 were on active service, while we are able at present to report a membership of 75 (with 14 overseas members).

It is very gratifying to state that of this increase in membership fifteen are new members of our society, while

there are still seven applications from our province pending to be dealt with by the council of the parent society, so that the outlook for the ensuing year in this connection is also very promising.

After considerable correspondence with engineers in this province and a number of organizing meetings, it was decided to enlarge the scope of our former Regina Branch and change the name to Saskatchewan Branch. Owing to a misunderstanding of our aims, the permission of the council of our parent society was withheld for some time. After same was obtained, the first regular meeting of the Saskatchewan Branch was held on May 10th.

There have been 9 regular meetings, 1 emergency meeting and 8 executive meetings, also an excursion to Fort Qu'Appelle to inspect the Sanitorium for Tuberculosis while under construction.

Some of the papers presented to the branch were as follows:—

"Some Aspects of Indian Engineering," E. G. W. Montgomery; "Drainage Problems in Saskatchewan," C. S. Cameron; "A Few Reminiscences of the Gallipoli Campaign," Capt. V. Michie; "Sewage Disposal," W. H. Greene; "The Sanitorium at Ft. Qu'Appelle," E. A. Markham.

The formation of our provincial library is well under way and a number of valuable donations have already been received.

The Regina Engineering Society decided during the year to discontinue its activities, wherefore the arrangement of joint alternate meetings was cancelled.

The executive council of the government of the province was petitioned, the advice and support of our members being pledged in all important questions.

At our annual meeting on January 10th, the following officers were elected for the ensuing year:—

Chairman, G. D. Mackie; vice-chairman, H. S. Carpenter; secretary-treasurer, J. N. de Stein; executive council, H. R. MacKenzie, E. G. W. Montgomery, W. H. Greene, C. J. Yorath and J. E. Underwood

CALGARY

DURING the past year there have been six general meetings of the branch, including the annual meeting in December last. The executive committee has held twelve business meetings. During the year the branch has been entertained by the following speakers:—

December 19, 1916—Capt. H. Sidenius, "Military Engineering and Trench Warfare in the European War."

January 18, 1917—C. W. Craig and J. F. Greene, "The Centre Street Bridge, Calgary."

February 15—W. A. Lamb, "The Water Resources of the State of Montana."

March 26—James White, "The Work of the Conservation Commission."

April 25—Col. J. S. Dennis, "The Part the Canadian Society of Civil Engineers is Taking in the War."

August 20—Fraser S. Keith, "Co-operation Between Branches and the Parent Society."

On the occasion of President Dennis' visit a dinner was given at the Palliser Hotel, which was attended by a number of ladies. The Roll of Honor of the Calgary Branch was unveiled by President Dennis on that occasion. The Roll of Honor was afterwards placed in the Calgary Public Library, where it is now on view.

At the annual convention of the Western Canada Irrigation Association at Maple Creek in August, our branch was represented by William Pearce and J. S. Tempest. The parent society was represented by the following members of our branch: F. H. Peters, S. G. Porter, C. M. Arnold and M. H. French, and by R. J. Burley of the Ottawa Branch.

A number of our members, under the chairmanship of P. M. Sauder, have co-operated with the Research Council in the distribution of questionaires, and in other matters pertaining to the work of the council.

The secretary of the Calgary Branch has acted as secretary of the provisional organization of the Alberta Division of the society. By-laws have now been approved, and it is expected that the first regular election of officers will be held this winter.

During the year we have perfected arrangements with the Calgary Board of Trade whereby an Engineering Section of the Board of Trade has been organized, which will deal particularly with the engineering phases of public questions which come before the board. The members of our branch who are also members of the Board of Trade, constitute the Engineering Section. They will have the privilege and will be expected in matters involving the general or local welfare of the engineering profession, or in matters in which the views or influence of the branch as an organization will be helpful, to refer them to the branch for consideration. It is expected that the relation which we have established with the Board of Trade will be of means of bringing our branch into closer touch with business and public interests and increase our usefulness to the community.

The executive committee has also taken the initiative in a movement to secure Dominion legislation defining the status of the engineer and giving adequate protection to the profession and to the public.

The annual meeting was held December 1, 1917, and the following officers were elected for the ensuing year:—

Chairman, Wm. Pearce; secretary-treasurer, C. M. Arnold; executive committee, A. S. Dawson, F. H. Peters, S. G. Porter, H. Sidenius and A. S. Chapman; auditors, W. J. Gale and J. S. Tempest.

The present membership of the branch is sixty-six.

EDMONTON

THE branch membership includes 56, of whom 21 are on active service.

The Alberta Provincial Division held the first annual meeting in Calgary on December 22nd.

Fraser S. Keith, secretary of the society, paid the branch an official visit for the purpose of getting personally acquainted with the branch membership and discussing society affairs. We think that this policy is productive of good results in co-ordinating the general membership of the society.

The status of engineers in Canada was the basis of considerable discussion. The branch membership is strongly of the opinion that this question merits the attention of the whole society.

The following papers were read before the branch:—

March 21st, "The Centre Street Bridge, Calgary," by Geo. W. Craig; May 11th, "Shell Manufacture," by J. Chalmers, supervisor of production, Imperial Munitions Board, Winnipeg.

The officers of the branch are as follows: Chairman, L. B. Elliot; vice-chairman, J. D. Robertson; secretary-treasurer, A. W. Haddow; executive, D. J. Carter, J. L. Cote, D. Donaldson and A. T. Fraser.

VICTORIA

THIRTEEN meetings were held during the year, with an average attendance of 10, and the following papers were read before the branch:—

February 7th, "Manufacture of Steel," R. R. Neild; April 11th, "Engineering Work in Seattle." A. H. Dimock; May 16th, "Sooke Water Supply System," C. H. Rust.

On February 26th a representative committee of the branch interviewed the newly elected provincial government premier and his cabinet ministers, placing clearly before them the national character, standing and aims of our society. An attentive hearing was given and many questions asked, the trend of which indicates that there is a great deal of educational work to be done by our members in Canada before the Canadian Society of Civil Engineers will be known and recognized by the public as one of the greatest assets in the development and progress of the Dominion.

At the commencement of 1914 our membership roll stood at 80, and since the outbreak of the war 33 have gone overseas on active service, where the "Last Post" has sounded over three. A fourth is held prisoner in Germany. At present the branch has 40 per cent. of its members with the allied armies, and we enter the new year with a membership of 74.

The annual meeting was held December 12th, the following officers being elected:—

Chairman, R. W. Macintyre; vice-chairman, R. Fowler; treasurer, E. Davis; secretary, E. G. Marriott; executive, the officers and W. K. Gwyer and E. P. McKie; auditors, C. Hoard and F. C. Green.

VANCOUVER

THE officers of the branch are as follows: Chairman, W. E. E. Carey; vice-chairman, E. G. Matheson; secretary-treasurer, F. P. Wilson; acting secretary-treasurer, A. G. Dagill; executive committee, C. Brakenridge, C. E. Cooper, H. M. Burwell and A. E. B. Hill.

ALBERTA DIVISION

AT the annual meeting in January, 1917, we reported a preliminary organization of the Alberta Division. On December 22nd, 1917, the division held its first regular annual business meeting, at which by-laws were adopted, officers elected, and other business transacted. The officers are as follows:—

Chairman, William Pearce; secretary-treasurer, Sam. G. Porter; executive committee, F. H. Peters, S. G. Porter, L. B. Elliott, A. T. Fraser, J. T. Child and J. G. McGregor.

BRITISH COLUMBIA DIVISION

NO formal meetings have been held, no funds have been received and no financial expenditures incurred. The Division is in a state of suspended animation.

It is felt that while there may possibly be a need for a provincial division in normal times, there is abundant excuse for the fact that no desire is manifested on the part of any of the members to divert any energy during these unprecedented days to the duplication of the work of the branches. The organization of the division will still be maintained.

ONTARIO HYDRO BUYS EQUIPMENT

At a recent meeting of the board of directors of the Ontario Power Company, of which Sir Adam Beck is president, the board approved of the arrangements made by Sir Adam with the Bank of Montreal for an advance of $1,250,000 required to construct the additional pipe line and two extra generating units at the company's plant at Niagara Falls. The cost of the work will be $1,800,000, the additional $550,000 being taken from the surplus derived from the company's operation. Sir Adam says that the bank loan will be repaid after two years of operation.

The contract for the two generators was awarded to the Canadian General Electric Company, while two S. Morgan Smith Company turbines were purchased from the Tallahassee Power Company, of South Carolina. The contract for the construction of the wood-stave pipe line, 13½ feet in diameter, was awarded to the Pacific Coast Pipe Company. The new generators will each have a capacity of 18,000 h.p.

At a meeting of representatives of the Hydro municipalities last week, Sir Adam stated his belief that the Commission would be able to complete the construction of the Chippewa Canal a year before the limit fixed before the war, as labor had been eliminated to a large extent by the use of heavy equipment. Six hundred men are employed on the work at present. Orders to the extent of $4,000,000 have been placed on the Chippewa development, but the money has not yet been forthcoming with which to pay for all of the equipment ordered.

"If 300,000 h.p. could be made available a year before we were counting on it, that would be of enormous value both to Canada and the United States," said Sir Adam, "as we are now allies fighting for the same cause and we should co-operate in the manufacture of war supplies and munitions."

The following resolution urging the Power Controller to commandeer the plants of the Canadian Niagara Power Co. and of the Electrical Development Co., was passed by the meeting upon motion of P. B. Yates, of St. Catharines:—

"That this meeting of the representatives of the Hydro municipalities demands of the Power Controller the operation of all generating plants by representatives of the Power Controller in order to secure an equitable division of all available power to the distributing systems affected, and that we urge instant action to relieve the present intolerable situation; and that we have reason to believe that there are some thousands of horse-power of electrical energy available which can be utilized over the lines of the Hydro-Electric Power Commission of Ontario, and that you order such power to be placed on these wires for distribution without delay."

Canadian Society of Civil Engineers

Report of Thirty-Second Annual Meeting Held Last Week in Montreal—Society Votes to Change Its Name—New Bylaws Adopted—Ceremony of Unveiling the Honor Roll—Fuel Situation Discussed

TO commemorate one way in which members of the Canadian Society of Civil Engineers have helped to win the war, an honor roll bearing 862 names was unveiled at the thirty-second annual meeting of the society, held last week in Montreal.

Realizing that nothing can be done by the engineers at home which will in any way compare with the sacrifices made by those 862 heroes, the members who attended the annual meeting felt reluctant to indulge in much discussion of the minor affairs of the society. Most of the sessions, therefore, were routine and perfunctory, with little interest taken in the work, and with but few new ideas of value introduced. One notable exception to this was in connection with the paper on "Fuels," read by B. F. Haanel. There the engineers saw a chance to accomplish some real work of value to the country, both in winning the war and in recovering from its effects, and they plunged into the discussion with vim and an evident desire to be of economic usefulness.

The scrutineers reported to the meeting that 440 ballots had been received on the new by-laws and 599 on the change of name, and that both propositions had carried by large majorities. The new by-laws go into effect at once, but the change of the society's name cannot be finally accomplished until Parliament consents to the necessary change in the charter. The new name is "The Engineering Institute of Canada."

The attendance at the meeting was smaller than that at several previous annual meetings. Only 153 were registered, of which 98 were from Montreal or suburbs, 14 from the Province of Quebec outside of Montreal, 19 from Ottawa, 7 from Toronto, 10 from Ontario other than Ottawa and Toronto, 3 from the Maritime Provinces and 2 from Winnipeg.

As previously announced, the president for the next twelve months will be H. H. Vaughan, of Montreal. The new vice-presidents are Prof. H. E. T. Haultain, of Toronto, and R. F. Hayward, of Vancouver. The new members of council are Prof. E. Brown, J. M. Robertson, Donald H. McDougall, Noel E. Brooks, John Murphy, Prof. Peter Gillespie, L. A. Thornton and Prof. E. G. Matheson.

Monday Morning Session

Only thirty members were present when Col. C. N. Monsarrat called the meeting to order at 10.10 a.m., Monday, January 21st, but this number was increased to fifty before the morning session was adjourned. Col. J. S. Dennis, the president, was unable to be present, so Col. Monsarrat, one of the vice-presidents, took the chair. F. S. Keith, the society's new secretary, read the minutes of the last meeting as recorded by the late Prof. C. H. McLeod. Upon motion of J. M. R. Fairbairn, seconded by Walter J. Francis, the following council resolution was unanimously adopted:—

"That this council record in the minutes of the society the sense of its great loss by the death of Professor Clement Henry McLeod, who for twenty-five years was the secretary of the society and a member of this council, and whose death removed from our midst one who was intimately associated with the welfare of the society since its inception, who was personally interested for forty years in the engineering education of a great number of young Canadians, and who had ever before him the best interests of the engineering profession in Canada. This council further desires to express its sincere sympathy to Mrs. McLeod and her family in their bereavement."

Letter from Col. Dennis

The following letter from Col. Dennis was read by Col. Monsarrat:—

"I am asking the chairman at the opening of the annual convention of our society to read this statement as an explanation to the members of my failure, as president, to be with you and preside at the annual meeting.

"For something over six months, at the request of the Canadian Government and as second in command of the British-Canadian Recruiting Mission in the United States, I have been devoting all my energies to the matter of endeavoring to secure recruits in the United States for our army. Our efforts have been met with a fair measure of success, as will be indicated by the fact that up to date we have sent to Canada something over 16,000 men.

"These duties have been such that it has been impossible for me during that period, as your president, to fulfil any part of my duties in connection with the society's affairs. In the early part of the year I tried to do what I could to assist in the reorganization of the society, so that its affairs might be put in a good condition, and I hope that you will be satisfied with the work then initiated, and which, during the latter half of the year, has been carried out so loyally by the members of the council, with the assistance of our able secretary, with the desired effect of rehabilitating the affairs of our society and putting them in good standing.

"My personal thanks are due to the vice-presidents, secretary and the members of council for the loyal way in which they have carried on the work without any assistance from me, and, while it was my hope during the year that when the annual meeting was held I would have been able to preside and feel that you appreciated the efforts made during the year, I hope that those in attendance will realize that only the importance of the duties that I am performing here has denied me that pleasure, and will feel that, as your president, the work that I have been able to accomplish in the United States has added one more evidence, if any were needed, that the members of the engineering profession attached to our society have been doing their bit to help Canada in our great struggle.

"I especially regret that I will not be present at the unveiling of our Roll of Honor of our members who are serving at the front. I feel that that Roll can, for all time, be pointed to as an evidence of the fact that the Canadian Society of Civil Engineers has responded nobly to the great Cause, and has proved, if any proof were needed, that the members of the engineering profession are always found in the front rank when duty calls.

"I trust that the annual meeting will be eminently successful in every way, and I extend to the members my sincere thanks for the great honor done me in allowing

me to occupy the position of your president during the past year, and assure the incoming president and members of council that I stand ready during the coming year or at any time to give them and the society every possible assistance in my power to continue the good work which has been begun to put our society in the position it is justified in occupying in Canada."

Reports of Standing Committees

R. A. Ross presented the report of the finance committee. He thought that the statement was creditable in view of the fact that $20,000 fees had been remitted during the past three years on account of members at the front. He estimated the value of arrears at $,5000, and said that each year, for several years past, $6,000 had been collected on this item. Probably another $6,000 could be collected this year, but then the remainder would have to be charged off the books, and this item would no longer be a source of revenue. Many names will have to be struck off the membership this year for non-payment of dues. Probably 250 men, getting the transactions and papers, are merely an expense to the society and should be cut off the list.

In discussing the report of the library and house committee, Walter J. Francis moved that the index of books in the library be prepared and distributed without delay, as recommended by the committee. The meeting felt that it would be better to leave the matter to the council, as the cost must be considered.

Branch Reports

The branch reports, which appear upon another page of this issue, were all read by the secretary with the exception of the Toronto report, which was read by George Hogarth, and the Ottawa report, read by J. B. Challies. R. A. Ross expressed the sentiment of the meeting in saying that great credit is due the Manitoba members for the good work they are doing as evidenced in their splendid report.

J. B. Challies suggested that each branch make a report to the annual meeting, showing what it has done with its finances. Some branches spend money in ways in which other branches do not, and the society in general should receive an annual balance sheet from each branch. The Manitoba branch, for instance, is publishing its own proceedings. The Ottawa branch has a substantial surplus, but never felt the necessity of publishing separate proceedings.

Sir John Kennedy and H. R. Safford supported this suggestion, but A. D. Swan enquired whether the parent society is responsible for the debts of the branches. If so, full statements should be submitted by the branches. If not, it is the branches' own business what they did with their finances. A suggestion was made that all branches be asked not to publish any separate transactions at the present time. It was moved and carried that each branch should hereafter submit a financial statement with its annual report.

Continuing this discussion at another session of the annual meeting, H. R. Safford introduced a resolution, asking the branches to discontinue publication of separate transactions pending the formulation of a definite policy by the society regarding inclusion of branch papers in the society's main transactions.

R. F. Uniacke asked whether this resolution would prevent the publication of branch papers in *The Canadian Engineer*. He said that very many branch papers had received early publicity through that channel, and he thought it was of value, and desirable that nothing be done to interfere with such publication. Mr. Safford replied that his resolution was not aimed at all at journalistic publication of branch papers, but was intended only to restrain the branches from spending the branch funds in publishing the papers in pamphlet form.

Walter J. Francis said that if the new by-laws were carried, Montreal would only be a branch and all branches would be on the same plane of equality, and that the transactions would then include the best papers from coast to coast, wherever read, and he thought that the problem would thus soon solve itself, and that all branches would see that separate branch transactions were unnecessary. Mr. Safford said that in that case no doubt the branch transactions would soon be automatically dropped by the branches themselves, anyway, and he, therefore, withdrew his resolution.

All Committees Dismissed

M. J. Butler, C.M.G., introduced the following resolution:—

"That it is the opinion of the meeting that the subject of special committees be reconsidered by the council, and that hereafter the appointment of such committees be limited to such subjects as define the quality of the materials rather than having the wide scope hitherto permitted to such committees."

The scope of committee activities should be limited, said Mr. Butler. Committees should not deal with the methods of using materials or with design or construction, but only with the materials themselves.

Sir John Kennedy spoke in favor of the motion. The society, he thought, was getting on dangerous ground in introducing specifications that were educational in character. It was not necessary to issue specifications to be used as text books by county councils, etc. The work of the engineering profession should be guarded in this connection. "The American and British societies of civil engineers are not doing it, but the Canadian society is going ahead, writing specifications on its own hook, without regard to any international standards," said Sir John.

Walter J. Francis saw no necessity for the society to write such a complete specification as to give the world at large the result of the best engineering investigation, and so clearly that almost anyone could follow the specifications and dispense with engineering services.

A. D. Swan also supported the resolution upon the basis of lack of standardization with British specifications.

H. H. Vaughan took issue with the previous speakers. He referred to the valuable work being done by the American Society for Testing Materials, and said that engineers disagree regarding both materials and their uses, and he saw no reason for making a secret of how materials should best be handled any more than of what standards of quality should be obtained in materials. The more publicity that is given to good methods of doing work, the better, he said. Take, for instance, the boiler code. How could a good boiler code be prepared without stating how the boilers were to be put together, how the seams were to be made, etc.? Those are the points on which publicity is needed. "Probably more boiler explosions are caused by faulty seams than from any other one reason," said Mr. Vaughan. "There may be a 'nigger in the fence' in this resolution. Perhaps it is aimed at the steel highway bridge specifications, which possibly should receive consideration before being

adopted, but I can see no reason for Mr. Butler's resolution."

R. A. Ross urged that all the existing committees be dismissed for the time being, subject to reappointment by council. The by-laws are being radically changed, the society is broadening out, and the council should have a free hand in appointing committees. There should be standards, but when applied to structures instead of materials, where was the society going to stop? Some committees are redundant and might be discontinued.

M. J. Butler said that standard specifications should prevail throughout the whole allied world. Societies here should work in co-ordination with British standard committees. Replying to Mr. Vaughan, he agreed that the American Society for Testing Materials is doing work of the utmost value to all engineers, and he said that is all the more reason why we should abandon our own committees, and, instead, accept the work of such standard committees. The only work for which specifications have been absolutely standardized is aeronautics. In building aeroplanes, the same words mean the same thing throughout all the allied countries.

The meeting voted in favor of Mr. Butler's resolution, and decided to discontinue all committees, subject to council's reappointing or reconstituting any that it might deem desirable.

Report of Conservation Committee

James White, deputy chairman of the Commission of Conservation, Ottawa, presented the report of the conservation committee, of which he is chairman. He said, in part:—

"Stimulated by the war and conditions created thereby, Canadians are to-day recognizing in greater measure than hitherto, that our resources are not as we so frequently designate them—'illimitable' or 'inexhaustible.' On the contrary, our wastefulness, our carelessness and our inefficient methods have, in some instances, made such inroads upon them that all but the ignorant and unobserving can see that nothing but the practice of economic and efficient methods will permit us to hand down to our posterity an inheritance that will suffice for their needs.

"One of the outstanding achievements of the year is the elimination of the curse of patronage in the matter of appointments by the Dominion government.

"The development of hydro-electric power in Ontario has been phenomenal. At present, the Hydro is delivering 296,000 h.p. and still is short 70,000 h.p. There is also a shortage of power in Eastern Ontario, although upwards of 60,000 h.p. is being exported from the Cedars Rapids plant to Northern New York State. The Cedars power is used by the Aluminium Co. of America in their Massena plant and by municipalities in the vicinity of Massena.

"Eight years ago the Commission of Conservation actively opposed the granting to private interests of the privilege of developing power at the Long Sault Rapids of the St. Lawrence. Recently the Commission has also opposed an application by private interests for permission to develop the Coteau Rapids power.

"In his annual address to the Commission of Conservation, November 27th, 1917, Sir Clifford Sifton referred to the Niagara Falls situation where we are exporting 125,000 h.p. and are unable to take it away from the manufacturing and other interests in the United States. He also advocated the development of the international water powers of the St. Lawrence 'by an international commission, under which the greatest and best use of the powers will be made, the most economical development will be effected, a just and equitable division of the power will take place and the governments concerned will be able to administer the power as the Ontario Hydro-Electric Commission administers the power of Niagara for the benefit of the people who are directly concerned in its use.'

"This pronouncement will appeal to the engineers of Canada as a progressive, a constructive and a statesmanlike policy.

"Sir Clifford also voiced a sentiment that will doubtless receive full assent and hearty approval from the members of our society. He said:

" 'We are still largely dominated in Canada by the idea that any ordinary capable amateur can do the work which ought to be done by a trained scientific man, and, until we eradicate this fallacy thoroughly, and, in its place, implant the view that men who are technically trained are the only men competent to deal with technical problems, we shall not begin to attain to general success in making the best use of the materials which are at our disposal.'

"In connection with the development of the water power of the rapids of the St. Lawrence an estimate of the power available is of interest. A. V. White, consulting engineer to the Commission of Conservation, estimates that the total maximum low-water, 24-hour horse-power is 2,395,000, and the average 24-hour, low-water horsepower is 2,150,000. Assuming an equal division of international powers, 1,955,000 h.p. of the maximum low-water power belongs to Canada and 440,000 to the United States.

"If we use the experience of the Ontario Hydro as a basis, we get a diversity factor of 30 per cent., which increases Canada's resources to the equivalent of 2,541,500 h.p. for maximum low-water power.

"The great conservation dam at La Loutre on the St. Maurice River is approaching completion. It will impound the third largest artificial reservoir in the world, being exceeded only by the Asuan dam on the Nile and Gatun Lake on the Panama Canal. The St. Francis River dam at the outlet of Lake St. Francis is also, nearing completion. The low-water flow of the St. Maurice will be doubled and the minimum potential horse-power will be increased by 550,000 h.p."

Mr. White reviewed successively the present conditions of Canada's forests, lands, minerals, fisheries and game, and also discussed the fire waste problem. "The United States is thoroughly scared over its declining pulpwood supply," he said. "We are so ignorant of our own supplies that we do not now whether to be scared or not."

Mr. White said that the white pine blister rust threatens with total destruction the most valuable forest tree in Canada. Our white pine has been valued at $200,000,000. The fungus lives alternately on the pine and on currant or gooseberry, wild or cultivated. If either be wanting, it cannot exist. It is a question, therefore, which is the more valuable and whether we should eradicate currant and gooseberry growths in order to save the pine.

"An example of wasteful methods is the coking of coal," said Mr. White. "At present there are in Canada approximately 1,700 beehive ovens with an annual production of 443,460 tons and 910 by-product ovens with a production of 1,005,322 tons. The beehive ovens waste all the valuable by-products.

"E. T. P. Shewen suggests the importance of commencing on an adequate scale the distillation of domestic coal, to recover the by-products, using the coke as domestic and other fuel.

"C. R. Coutlee suggests the handing over to the Federal government of provincial interests on rivers of 20,000-square-mile drainage areas and of sufficient flow, with a view to ideal development of power at public expense."

Mr. White also presented a long but most interesting report by C. E. W. Dodwell, covering a wide range of important conservation topics, including denatured alcohol, fuels and natural resources, and this report will be printed by the society as a part of the conservation committee's report. Mr. Dodwell lays especial stress on the statement made last year by Mr. Shewen that "in exporting raw material, a country derives from its natural products the least advantage."

Col. R. W. Leonard commented upon the general review of the Conservation Committee as follows:—

"The remarks on the devising of fire places and furnaces which would render coke as satisfactory as coal for domestic use, recall to my mind that most of last winter I burned coke in my house furnaces with excellent satisfaction, it being quite as good as anthracite coal, but because it burned more freely, the draughts had to be regulated a little closer and the fire required more frequent attention in cold weather.

"The other remark on the conservation of the use of coal by extracting the by-products first and burning the coke for domestic use afterwards is, I consider, eminently practicable, and I see great possibilities in large centres of population by importing bituminous coal, coking it in by-product ovens, using the gas directly for heating, lighting and generating electric power, saving the tarry and ammonia by-products and using the coke for industrial and domestic purposes.

"Such an industry would require a very large expenditure of capital, and if this capital is to be subscribed by private investors, great care must be taken to regain the confidence of the investing public in the permanence and success of public utilities and the prospect of favorable returns on their investment."

Mr. White announced that W. F. Tye, a past-president of the society, had just been elected a member of the Commission of Conservation, to succeed the late Sir Sandford Fleming as the society's representative on the commission. Mr. White also announced his own resignation from the council of the society, stating that he intended to place same in the hands of council at a very early date. He had consented to be a candidate for election to council just for the purpose of obtaining certain reorganization that had now been effected, and he had intended to remain on council only for six months. Subsequently, he had been urged to continue, and had done so for another six months, but now that he had served twelve months on council, he intended to resign, owing to certain conditions which he had met within council, and which prevented him from doing his best work while on that body.

J. B. Challies said that he was a member of the committee of conservation, and that the committee never had a meeting, so that to Mr. White must go the credit of the whole report. Mr. White had given him an opportunity of reading his report, however, shortly before the annual meeting of the society, and certain changes in the report had been suggested, all of which Mr. White had subsequently made. The Ottawa managing committee did not know that Mr. White had intended to resign from council, and he was sorry that Mr. White had decided to do so, as Mr. White had been of much help to the managing committee of the Ottawa branch.

Adjournment was then moved, at 1 p.m., the discussion on the report of the conservation committee to continue at 3 p.m.

When the meeting was called to order for the afternoon session, James White moved that the members should signify to council their desire to continue a conservation committee, in view of Mr. Butler's motion disbanding all committees. After considerable discussion regarding the propriety of such a motion, which some thought might tend to tie council's hands and nullify Mr. Butler's motion, the resolution, as submitted by Mr. White, was passed with only one dissenting vote. Upon amendment by Mr. Challies, a rider was attached to the resolution, stating that the committee's functions were to be defined by council.

Col. Leonard Makes Interesting Announcement

Referring to conservation work, Col. R. W. Leonard made an interesting announcement regarding experiments on the Sudbury nickel dumps. These experiments were carried out at the Montreal East steel plant of the Canada Cement Co., where it was found that a high-grade alloy steel, containing copper and nickel, could be manufactured from the large resources available to Canada in the Sudbury dumps. No nickel steel is being manufactured in this country at present, said Col. Leonard, and the Sudbury dumps should be treated while the present high prices prevail. The roasted ore had been reduced to pig in electric furnaces. The objections to copper in steel were found to be based on prejudice and not on fact. By request of the meeting, Col. Leonard agreed to have the engineer in charge of the experiments write a report about the process, to be included in the printed proceedings of the society.

Roads and Pavements Report

In the absence of W. A. McLean, the chairman of the roads and pavements committee, the secretary read the following report.—

"Following the formation of the committee in 1915, the opinion of the members was sought with a view to deciding on what lines information was most generally required. It appears that a survey of the methods and costs of pavements of various types would result in the securing of valuable data, and that, in addition, there was a need for reliable specifications for the materials used in road and pavement construction.

"Your committee, therefore, proceeded to work on two definite lines: First, the collection of information concerning the construction of pavements with a view to correlating it with information received at later dates, indicating the success or failure of different methods of construction; and secondly, the compilation of specifications for road-building materials.

"In the report of the committee, presented at the last annual meeting to the society, a list of the pavements concerning which information had been received was given, specifications for crushed stone, gravel and sand were presented for adoption by the society; and a progress report on specifications for asphaltic road oils, with tentative specifications, were included

"The specifications for crushed stone and gravel have been used by members of the committee and others, and up to the present no suggestions for improvement have been received. As there was a lack of uniformity between the specifications for concrete sand issued by the committee on concrete and reinforced concrete and those issued by this committee, it was suggested that the two committees consider the matter together with a view to

obtaining a uniform sand specification. While steps in this direction have been taken, insufficient progress has been made to enable the committee to offer a revised specification. It is anticipated that during the coming year a satisfactory specification for concrete sand will be evolved.

"Progress is being made in the preparation of further specifications for materials, but they are not sufficiently advanced to submit to the society. The attention of the society should be drawn to the fact that those submitted in the last annual report of this committee were of the nature of a progress report only, and were not put forward for use by the membership, but for discussion only.

"Progress has been made with regard to the collecting of information concerning the construction of pavements. During the early part of the year blank forms were sent to the engineers of sixty of the cities and large towns of the Dominion with a request that pavements constructed under their supervision be reported on. The number of reports received, including those summarized in the last annual report of the committee, makes a total of 122 pavements, which number will be increased considerably before the end of the year. This means that your committee has under observation, through the cooperation of the municipal engineers throughout the Dominion, the aforementioned number of pavements."

Walter J. Francis moved that the meeting receive the report and recommend to council that the committee be continued. Sir John Kennedy enquired whether the committee was not getting perilously near teaching municipalities how to build roads. He thought the tendency dangerous if carried too far.

Electro-Technical Commission

Secretary Keith read the following report of the Electro-Technical Commission:—

"The committee begs to report that during 1917, as in the two years previous, the commission's activities have, of course, been considerably curtailed, though the central office in London has done all that was possible under the circumstances to keep the organization together and to forward the work.

"To this end, and because of the importance of the subject, a conference on the rating of electrical machinery was held in London in September, the meetings being attended by delegates from the British and United States committees, and by A. P. Trotter, consulting engineer, of London, who very kindly accepted our chairman's invitation to represent the Canadian committee.

"When the work of this conference is finished, and all details settled, another great step will have been made towards world-wide electrical standardization, with all its attendant advantages. For instance, to mention just one, all tenders, whether from manufacturers of the same or different nationalities, will then be comparable on a uniform basis as to performance claims, guarantees, etc. —a condition that has not always obtained in the past, although obviously most desirable."

Walter J. Francis moved that the report be received and the committee continued. Carried.

Steel Highway Bridge Specifications

P. B. Motley, chairman of the committee on steel bridge specifications, presented the following report:—

"I beg herewith to transmit a specification for steel highway bridges, including movable bridges, as recommended by your committee on steel bridge specifications.

"This committee has had eight general meetings, as well as numerous sub-committee meetings, during the year, attended by most of the Montreal members, and the results of the meetings have been communicated to the branch members for their information and remarks.

"After considering all discussions sent in, draft specifications for highway bridges have been respectfully submitted to the society. The committee has also given some attention to the existing specification for fixed steel bridges, and is of the opinion that it be corrected and revised as regards sequence, etc., generally in accordance with the highway bridge specification now presented. It was, however, found impossible to deal with the matter during this season.

"The specifications resulting from the work of this committee are intended to be recommended practice for use of public bodies, such as the federal and provincial governments, commissions and municipalities. They are not intended to take the place of a duly qualified consulting engineer, but to form a basis for specifications drawn up to meet the requirements of the case in hand.

"It was thought by some members of the committee that it would be proper to recommend a series of suitable loadings for given widths and classes of highways. These are put in the form of a short preamble, and are capable of variation and interchange by the user.

"A schedule of information to be provided bidders is also attached.

"It is recognized that there are a number of clauses that are open to discussion, such as impact, unit stresses, column formula, lattice bars, etc. All these controversial points have received careful attention, and, while they are still in a more or less inconclusive stage, it is thought that the specification represents the best and most recent practice, and it is hoped that public bodies will be inclined to use it as extensively as possible, so that uniformity, and, therefore, economy may be secured in the bridge construction of this country.

"While the earlier drafts of the report have been sent to the branch members of the committee, it has been impossible to send them the final draft, because the work of revision has continued to the present time.

"As the work of the committee is continuous in its nature, it is recommended that it be continued to include the revision of the present railway fixed bridge specification and reinforced concrete bridges."

R. F. Uniacke said that the Ottawa branch thought that the specification was not so full as that in use by the Ontario Department of Highways and the Ontario Railway and Municipal Board, but that as the specification had already been printed, he moved that it be received.

W. Chase Thomson said there are some errors in the tables which should be corrected before the final specification is printed. Mr. Motley replied that there are no typographical errors, but that possibly the arrangement of some of the tables could be altered so as to make them clearer.

Prof. Mackay said that there are some formulæ and requirements in the specification which might be criticized, but that, as the specification is still tentative and in draft state, that there was no need to take up the time of the meeting by discussing these technical points, as no doubt the committee would gladly give earnest consideration to all suggestions anyone might make tending toward the improvement of the specification, and that these suggestions could be brought before the committee from time to time during the coming year.

Education and Board of Examiners

Prof. H. M. Mackay, chairman of the committee on education and of the board of examiners, presented the following report:—

"Since the fusion of the committee on education with the board of examiners, regular meetings have been held monthly, or more frequently when occasion demanded, in convenient relation to the meetings of council. In this way it has been possible to consider applications for admission or transfer with the least possible delay. In addition, a considerable number of applications held over from previous years have been dealt with, and the work of the committee has been brought quite up to date.

"Examinations for candidates seeking admission or transfer were held in July and November as follows:—

"Subject.	Candidates.	Passed.
"Theory and Practice of Engineering..	4	2
"Railway Engineering	3	3
"Hydraulic Engineering	2	2
"Total	9	7

"The work of the committee would be greatly facilitated, and it is believed the standards of the society would be improved, if branches and members generally would urge upon candidates, whose educational attainments are not strictly in accordance with the by-laws, the desirability of preparing and presenting themselves for these examinations."

Concrete and Reinforced Concrete

Walter J. Francis, chairman of the committee on concrete and reinforced concrete, presented the following report:—

"Your committee has held no formal meetings during the year, but the individual members have given considerable attention to the question of revising the present standard specifications. They have also studied the final report of the joint committee on concrete and reinforced concrete, in which members of the American Society of Civil Engineers took part.

"In view of the fact that no complaints or adverse criticisms of the existing standard specification for concrete and reinforced concrete have reached the committee, that a number of the members know the standard specification to be serving a useful purpose as a general specification, that further time is desired in which to study the suggestions made in the report of the joint committee of the American societies, and the discussions which are still being carried on in connection therewith, and that printing expense will be saved by refraining from making alterations to the standard specification, your committee desires to recommend that the standard specification for concrete and reinforced concrete be permitted to stand for another year, and that the committee be continued." Received and adopted.

These Committees Did No Work

Letters were received from the chairmen of the steam boiler specifications committee and the committee on general clauses for specifications, indicating that no meetings had been held and no progress made in their work owing to war activities. It was suggested that Mr. Butler's motion could be applied to these committees, and that they be discontinued. This was left to the consideration of the new council.

Committee on Society Affairs

Walter J. Francis, secretary of the committee on society affairs, read the final report of that committee, which consisted merely of a brief letter, stating that the committee's work had been finished, and asking that it be discharged. A motion to that effect was carried.

Portland Cement Specifications

The secretary read the report of the committee on Portland cement, as follows:—

"When this committee was appointed by the council, no instructions were given as to the work to be done by the committee; therefore, in the absence of anything definite along these lines, they thought that the examination of existing specifications would be most beneficial to the society.

"In the United States a joint committee, consisting of representatives of the American Societies of Civil Engineers, the Society of Testing Materials, the Railway Engineering Association, the Concrete Institute, the United States Government, the Portland Cement Association, the Institute of Architects, and other affiliated organizations, was formed in 1904, and have recently prepared and recommended a standard specification for cement which has been adopted by the said societies.

"These specifications, together with the British standard specification prepared by the Engineering Standards Committee, supported by the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, and the Institution of Electrical Engineers, and other most eminent engineers in Europe, were compared and analyzed.

"Your committee, realizing that it is desirable to have as uniform a specification as possible, compared the present Canadian specification with the new American specification and the British specification, and decided that certain features in both specifications did not appear suitable to Canadian conditions.

"Your committee recommends that the magnesia content should not exceed 4 per cent., at least until such time as more information may be had as to the results obtained by the use of a greater amount of magnesia.

"In the American specification, the test for tensile strength with briquettes of neat cement has been omitted. Your committee feel that this test should remain, omitting the 24-hour test and reducing the 7-day and 28-day requirements to 450 pounds and 580 pounds respectively, thus reducing the tendency of manufacturers to produce cement giving a high tensile value on the shorter test, to the detriment of the longer one. The committee considers, however, that more reliance may be placed in the results obtained from the cement and sand tests.

"The Canadian cement manufacturers have objected to increasing the weight of cement in each sack to 94 pounds. Your committee accordingly gave this matter mature consideration and decided to recommend that the weight of 94 pounds per sack, as formerly recommended, should be adhered to.

"Inquiries were made of many of the various works departments of cities and government departments in Canada, to ascertain what specifications were used and to obtain suggested amendments. Replies indicate that the Canadian Society specification was used in most cases, but nearly all seemed to be awaiting the results of the work of the joint committee mentioned before. Since the American specification has been published, numerous communi-

cations have been received from works departments, railways, and others, that they concur with the findings of that committee.

"Your committee, therefore, respectfully recommend the adoption of the specification, as prepared by the joint committee aforesaid, subject to the alterations and additions as herein set forth."

J. A. Jamieson, in discussing the report, said that it should be referred back to the committee, as it does not agree with American or English specifications, and he wanted information on why it should disagree.

R. A. Ross enquired whether it would not be better to adopt standard specifications used by other countries than to try to write separate specifications to meet our own comparatively little needs in Canada without linking up with any outside standards.

A. D. Swan said the committee had put the magnesia content maximum at 4 per cent. in order to split between the English 3 per cent. and the American 5 per cent. In the 7-day test, the committee had followed the English amended specification.

J. A. Jamieson persisted in an effort to find further information as to what had formed the basis of the 4 per cent. requirement. Had the committee conducted any experiments of their own to establish that percentage?

Mr. Swan replied that it was based on 110 letters received from the most eminent engineers in Europe and America; that it was the requirement of the Panama engineers in all Panama Canal work; that it was the requirement of the Public Works Department of Canada; and that it was the result of tests upon which the British standard specification was founded and which he had supervised.

Mr. Jamieson thought that the question was purely a chemical one, combined with the question of the temperature at which cement clinkered, and that unless viewed from that standpoint, any magnesia requirement meant nothing. The Bureau of Standards of the United States had shed much light upon this subject.

Arthur Crumpton stated that the joint committee in the United States had labored over five years on this point, with extensive laboratory research, and that they had found that cement containing 7 per cent. or 8 per cent. magnesia was as good as that containing 5 per cent., and that therefore any lower limit than 5 per cent. was totally unnecessary. R. J. Wig, of the United States government, feels that the joint committee specification meets the requirements so far as they can be met. There is a feeling that the joint committee favored the manufacturers. That is not so. Theirs is a consumers' specification which is practical and has been agreed to by the manufacturers. The manufacturers should not be asked to subscribe to irksome and unnecessary restrictions. The fineness requirement must be considered. By allowing the extra 1 per cent. magnesia, the fineness requirement could be met more cheaply, with the result that as good a cement would be obtained at a lower selling price.

Mr. Jamieson was not sure whether the extra 1 per cent. magnesia would cheapen cement manufacturing costs, but he said that it would have a tendency that way on account of widening the field of materials which would be suitable and thus possibly lower the raw material costs to some manufacturers.

F. B. Brown urged uniformity with the American specification. He advocated the discarding of the neat cement test and the judging of cement by the quality of the mortar it could produce.

Col. Leonard was not in favor of adopting the American specification. Why not write specifications to meet our own conditions? Why should American work be copied wholesale? Our own committee should be backed up in its investigations.

J. A. Jamieson was strongly in favor of increase of strength with age. The American weakness, he said, is retrogression with age.

Sewage Disposal and Sanitation

Prof. Peter Gillespie offered to the meeting a report which had been made to the Toronto Branch by the branch committee on sewage disposal. After he had read the report, it was referred to council for further consideration, no action being taken on it. The report was as follows:—

"The committee appointed by the Toronto branch, re sewage disposal, has held five meetings since September last, at which many questions connected with sewage disposal were discussed and considered, and at a final meeting held on the 14th instant, it was decided to submit the following recommendations to the branch for submission to the parent society:

"1. That the provincial public health acts of the different provinces should provide that two or more members of each provincial board of health shall be engineers and corporate members of the Canadian Society of Civil Engineers.

"2. That the provincial public health acts should provide that all reports, plans, etc., respecting schemes for sanitation and sewage disposal required to be filed by provincial authorities, shall be prepared, singed and submitted by an engineer, a corporate member of the Canadian Society of Civil Engineers.

"3. That Dominion legislation should be enacted respecting the pollution of international and inter-provincial waters, and that provincial legislation in the different provinces, respecting stream pollution, be made uniform as far as practicable.

"4. That the public health act of each province should give to the provincial boards of health some measure of control over the operation of municipal water purification plants and sewage disposal works.

"5. That all provincial public health acts should stipulate that no municipality can submit to the votes of the electors, any by-laws providing for the raising of money for the construction, alteration or extension of any waterworks system or water purification works, or of any sewage system or sewage disposal works, without having had the approval of the provincial board of health, based on plans, reports and designs submitted by engineers.

"6. That the keeping of accurate and up-to-date records of all extensions and services added to sewer and waterworks systems, should be required of municipalities by the provincial board of health. Where municipalities have no system of their own for keeping such records the adoption of a method endorsed by the provincial board might be insisted upon.

"7. That where provincial boards of health maintain laboratories for the investigation of problems in public sanitation, such laboratories might, under reasonable conditions, and with much advantage to the country, the engineering profession and the boards themselves, be placed at the disposal of this society and, through it, of its members who have problems in municipal sanitation for which they desire solutions.

"The committee proposed to submit recommendations respecting rules and regulations covering the filing of plans, reports, etc., respecting waterworks systems and sewerage systems; first, existing systems, second, projected systems, and third, extension to works, but we

found the time too limited for proper discussion of those important matters. We would, however, recommend that this committee be continued, and that the scope be broadened to more clearly include water supply and water purification and problems of interest to sanitary engineers."

James White said that the Ottawa branch is in favor of engineers being on the boards of health, and that medical men on such boards had admitted that the engineers should have places on the boards. He referred to the recommendations that had been made along this line by the town-planning adviser to the Commission of Conservation.

Award of Medals

The Gzowski medal committee reported its findings and awarded the medal for this year to William Francis Tye, past president of the society, for his able paper on "Canada's Railway Problem and Its Solution." The student's prize was awarded to W. R. Way for a paper on insulated power cables. The Monday afternoon session was then adjourned.

The Fuel Situation

A dinner was tendered the visiting members on Monday evening at the University Club, followed by a smoker and entertainment at the society's headquarters which was attended by a large number of Montreal members and all of the visiting members.

The members reassembled at 10.35 a.m., Tuesday, to hear an address on "Fuels," by B. F. Haanel, B.Sc. Arthur St. Laurent, vice-president of the society, presided. The registration, which had been 68 at the end of the first day, had grown to 101, and the session was well attended. After Mr. Haanel had finished reading his paper, which is printed in full in another part of this issue, Mr. St. Laurent called for discussion.

Walter J. Francis explained that C. A. Magrath, who had intended to be present to take part in the discussion, had been called to Ottawa, and that Mr. Surveyer, of the Research Council, was also unable to be present. Mr. Francis referred to the memorandum on industrial preparedness, which, he said, was responsible for the subsequent appointment of the Research Council, and announced that his confrere in the preparation of that memorandum, Mr. Ross, who was also a member of the Research Council, was present and would take part in the discussion.

J. W. Harkom said that he had been a member of the society since its establishment, and that in his opinion the society had never been presented with a paper of such value and importance as that by Mr. Haanel. From 1874-6, peat fuel from the St. Hubert bogs was used on the C.P.R. It was found perfectly practical to run on that fuel. The peat was pressed into briquettes. It kept the firemen very busy, however, and constantly fell to pieces when shovelled, so it was found advisable to revert to wood, which was used until supplanted by coal. But peat is fuel of value, and more use should be made of it in some districts. The conservation of fuel is the most important problem before Canada to-day. Waste has been the curse of the country from the farmer's woodpile to using coking coal for fuel purposes. By-product plants should be encouraged. One blast furnace he had visited on the Clyde had established a by-product recovery plant which had paid for itself in five years and which shipped tar, creosote, ammonia and other products, in astonishing quantities, to the West Indies and elsewhere.

Mr. Haanel said that the state railroads in Sweden run on peat powder and have found that one and four-tenths tons of peat powder equal one ton of good Welsh coal.

R. A. Ross, member of the Honorary Advisory Council for Scientific and Industrial Research, showed a large map on which was indicated the fuel and water power resources of Canada. He said that when coal is selling at $130 a ton in Italy and $60 a ton in Paris, and when we are shivering on the brink of possible stoppage of imports of coal from the United States, we begin to realize how much our civilization depends upon energy. Mr. Haanel's paper shows what a big job the Canadian engineers have to face.

Develop Water Power Resources

Only 12% or 13% of our imported coal, said Mr. Ross, is used for domestic purposes. The remainder is for the production of power. The problem is therefore not solely one of fuels, but one of energy resources, and our "white coal," or water powers, must be taken into consideration.

"The United States has 'treated us white,' " said Mr. Ross. "Next winter, I fancy, we are going to be up against it hard if we do not do what we can to supply our own energy requirements and not lie down supinely. Ontario has no coal but abundant water power for all power needs. The only fuel imports Ontario should need are for heating. No coal should be needed for manufacturing purposes, broadly speaking."

Water powers and fuel resources should be developed jointly, said Mr. Ross, adopting different policy of developments in different districts to meet the different requirements of the districts. Saskatchewan and Alberta, lacking water power, will have to develop their own fuel resources.

By-products cannot be overproduced with economic results. It is an engineering problem to determine when to recover by-products and whether peats and lignites should be burned under steam boilers or made use of by means of gas producers and gas engines.

Pressure should be brought to bear upon the government from every possible source. The whole matter is in the hands of the government and governments rarely act excepting under pressure of public opinion or pressure exerted by private interests. Scientists in the employ of the government have collected an immense mass of information which has been embalmed in green or blue covers and filed on shelves. These scientists and engineers in government service want to put their work to some useful purpose, but they often cannot arouse interest by their own efforts and, said Mr. Ross, "it is up to the Canadian Society of Civil Engineers to help them."

The Research Council has been urging the government to establish a briquetting plant in Saskatchewan, to handle lignite, but so far the government has taken no action. Satisfactory briquettes can be made and a full size commercial plant should be established to see how cheaply they can be made upon a commercial basis. Possibly by-products of the plant could be obtained to cheapen the binder used in the experimental briquettes.

"The fuel situation is an engineering problem," said Mr. Ross, "and the engineers should get into it. If it were a medical problem, the doctors would be in it at once; if it were a legal problem, the lawyers would be there; and if the engineers don't tackle the fuel problem, the lawyers will!"

Possible a ministry of power and fuel might be needed to administer the solution of the problem, said Mr. Ross. The Dominion government, provincial governments and private interests are involved. Some sort of a super-

commission may be needed to get the Dominion and the provinces together on the question without delay.

Walter J. Francis introduced a motion which was passed unanimously by the meeting, that Canada's water powers should be developed as rapidly as possible so that we will be able in time to supply our own needs to a large extent, and not be a burden on the coal resources of our neighbors.

J. B. Challies urged that the Public Works Department, the Department of the Interior, and the Department of Railways and Canals should join forces in this problem, just as the United States departments have done in the recent Water Power Administration Bill.

Engineering Involves the Dollar

Col. Anderson thought that the fuel situation is as much a financial topic as an engineering problem. The question is, where can we get the cheapest fuels to do the work? Mr. Ross replied that it is an economic problem entirely. It is a question of the dollar, but if engineering cannot produce the dollar, it isn't engineering.

In reply to a question about the oil sands of the Peace River District, Mr. Haanel said that they were too far from the sources of cheap fuel required to heat them to recover the oil. They contain only 10% to 12% bitumen, and it does not pay just now to haul a ton of sand a long distance to recover 200 lbs. of bituminous oil.

Col. Anderson called attention to some old experiments tried by the Royal Navy in regard to briquetted Welsh coal, and which were not thought to be very successful, while Col. Leonard brought to the attention of the meeting some experiments on anthracite coal dust, or culm, which have been very promising. Asphalt is used as a binder, requiring only one dollar's worth of oil asphaltum per ton of briquettes.

Jas. White called attention to the value of wood as a solution of the immediate fuel difficulties. General Bertram urged the development of all of our own resources, and instances which he cited showed that the general is a keen advocate of development within Canada, and that he had done a great deal in the past toward initiating Canadian enterprises for the working up of the country's raw materials.

W. J. Dick said that the coal fields in the United States are being rapidly exhausted, and that they may not be able to fulfil the requirements of that country for more than another ninety or one hundred years. The annual production is constantly falling off about 1% per annum, due to increasing difficulties in mining.

A. St. Laurent, assistant deputy minister of public works, urged that a study be made by the society of navigable rivers in reference to power development. He said that his department has to be very careful in permitting developments on such rivers. Not only must the interests of navigation be guarded, but also care must be exercised that in permitting one site to be developed, another better site be not injured.

J. G. G. Kerry did not want the society to discuss power development from financial and economic viewpoints. He thought the engineers should stick strictly to the technical or engineering side of such problems. R. A. Ross took issue strongly on this point, claiming that no body of men is better qualified than is the engineering body, to discuss the broad economics of such national questions. The whole matter is an engineering one. It is purely a question of tracking to his lair, the elusive B.t.u.

As a result of this discussion, the motion previously introduced by Walter J. Francis was again approved heartily by the meeting. The exact wording of the motion was as follows:—

"That this meeting recommend to council the appointment of a committee to make representations to the Dominion Government regarding the advantages and benefits of a progressive system of development of our fuel resources in combination with our water powers to the end that the best uses be made of all of our resources."

Tuesday morning's session was then adjourned.

Unveiling of the Honor Roll

When the meeting was resumed about 3 o'clock Tuesday afternoon, Mr. St. Laurent announced that the honor roll would be unveiled by Lieut.-Col. S. H. Hill, in the absence of Col. Dennis, the president of the society, who had intended to officiate upon that occasion. General Wilson, commander of the Montreal military district, had been invited to unveil the roll, but his duties prevented his attendance. He sent as his representative one of the most distinguished members of his staff, Col. Hill, who had seen years of active service at the front with the Princess Patricias and with the 23rd Battalion.

Mr. St. Laurent said that he felt the unusual solemnity of the occasion, which would be an historic one with the society, particularly as many of those he was addressing had sons at the front.

"I myself," he said, "have a son on service, and I am proud of it. It would have been one of the lasting sorrows of my life if my son had not come to me two years ago and said he desired to go willingly to do his share at the front. However, I am not forgetting that many who otherwise would have been on the Honor Roll to-day have been kept at home and do their work here to ensure the victory and lasting peace we are all looking and working for."

The members then descended to the entrance hall of the society's building, where Lieut.-Col. Hill unloosed the flags which covered the Honor Roll.

"I have been asked by Major-General Wilson," said Lieut.-Col. Hill, "to represent him on this occasion. I find that you have 862 names on your Honor Roll. In face of such a record it would be fulsome on my part to add words of praise for the wonderful showing your society has made."

With regard to the Honor Roll, Lieut.-Col. Hill said that it is believed that over a hundred names should still be added, as there are 200 members of whom trace has been lost, and of whom it is believed at least half have enlisted for service.

Information has been received of the deaths of 58 of the members, most of whom were killed in action, and there is no doubt that others have fallen of whom no records have yet been received. In addition to these, no less than 65 of the members have been decorated for gallantry in action, including Corp. P. L. P. Lecointe, who has won the Croix de Guerre with a star (equivalent to a medal bar), who had been wounded, discharged, and was present at the ceremony.

One past president, Lieut.-Col W. P. Anderson, had three sons at the front, all of whom had won the D.S.O. Another past president, G. H. Duggan, had two sons killed in action, while another past president, Sir John Kennedy, had lost a son facing the foe.

As an infantryman, Lieut.-Col. Hill spoke in appreciative terms of the manner in which he had seen the en-

(Continued on page 42, Construction News Section)

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Principal Contents of this Issue

CHEMICAL RESEARCH

If the cabled report of the discovery, by United Kingdom interests, of German dye secrets, is correct, a strong weapon against enemy trade after the war will be available. The Imperial, Canadian and United States governments are all devoting considerable attention to the development of the dye and chemical industries. The British government has a substantial interest in an important dye manufacturing corporation and has appropriated a large sum for experiments. The United States government is actively engaged in furthering the dye and chemical industry in that country. Canada has appointed a special commission to investigate these and similar matters. Inquiry is also being made into the production of potash. Germany is said to hold the world's monopoly in this commodity. All the valuable deposits are under German control, the principal source of potash being at Stassfurt. Attempts are now being made in Canada and the United States to produce potash from feldspar and from other resources. A Toronto company is already engaged in experimental work with that object in view and a large Montreal concern has announced its intention to enter this new sphere as a side line. While we must depend upon individual initiative to a great extent for the development of new industries, it is reasonable to expect enterprising governments to encourage experiments of this nature with practical support. The United States, it is understood, has offered as an inducement in research, a large sum to the citizen who can produce potash from one or more of the natural resources of that country, and in quantities which will give an adequate supply.

ENGINEERING INFLUENCE

It is an assumption common enough to believe the idea widespread that for considerable success in any sphere of activity the most important asset is that of influential friends. Indeed, it has been said more than once that the greatest luck which can befall any man is that he chose his parents wisely. Where a belief is widespread there is usually an underlying truth, while it is also not uncommon to find severe limitations to the popular assumption.

Success is not independent of initial advantage, although cases can be quoted where the start was at so low a level as to constitute little or nothing advantageous. What does seem extraordinary is, where men have outstanding initial advantages and do not avail themselves of their birthright. For some reason or other they forfeit the chances of an enviable beginning and perhaps because of the lack imposed by the discipline of circumstance, refuse to fit themselves in the highest manner to an end well within their reach. The man who is without initial advantage has thereby a longer road to travel and he sacrifices some of the best of his youth merely to make a beginning. Still, the lean years, for all their drawbacks, do possess sterling advantages although they must in many ways penalize the individual.

Natural handicaps set by circumstance can be overset by high endeavor, the cases where the very handicap itself has been turned to advantage is proved in the case of many successful men. There is something sure in a foundation which has its beginnings on a solid bottom.

The question of influence has many ramifications. It is perfectly certain that all the influence in the world cannot foist an incapable fool on the community in a professional capacity. He may, however, out of public money, be found a safe job free from competition.

In the professions, and in industry generally, wherever the element of competition is present it ensures some measure of capacity. The initial advantage is often made non-effective by a want of natural sense. It is, as a shrewd technical man once pointed out, extremely difficult to keep brains down. While the final result may be less, the total by comparison is greater.

Whether it is possible to assess success at all, may be debatable.

There is another form of influence not always realized: it is the reaction each individual makes upon his immediate associates, his profession and the time and place wherein he lives. The results are intangible but none the less real, for no man lives to himself, nor ought he try so to do. It is the special privilege of some to exert abiding influence while tangible reward to themselves is lacking.

The question of influence of communal character explains why many capable men tackle troublesome public tasks. It is not so much to be in the public eye as to be of public use to the community. Since each derives advantage—safety, peace and service—from the communal stock, so each should be willing to place themselves in accordance with their capacity at the service of the community. Unless men are public-spirited, democratic government is a failure; it certainly is less successful if men peculiarly fitted withhold themselves and refuse to entertain posts of public responsibility.

Too much has already been left to those who make a trade of the business of government; too little has been done by those having executive ability, high intelligence, education and training. In the interests of the public at large the custody of public interests should be entrusted to a wider range of individuals.

PERSONALS

H. R. SAFFORD, chief engineer of the Grand Trunk Railway, has been nominated for the vice-presidency of the American Railway Engineering Association.

E. A. O'DONNELL, recently appointed superintendent of terminals of the Southern Pacific at Houston, Texas, was born at Navan, Ont., and received his upper school education in Ottawa.

Bomber H. B. NORWICH, a student of applied science, class of 1916, University of Toronto, has returned to Toronto after three years of active service. Bomber Norwich enlisted in the 2nd Division Cycle Corps and went to England with the 2nd Contingent.

Captain R. J. DURLEY, M.E., Montreal, has been made a member of the Order of the British Empire. Captain Durley, who is by profession a consulting engineer, specializing in heating and ventilation, holds a position in Ottawa under the Imperial Munitions Board.

Capt. A. ROSS ROBERTSON, B.A.Sc., of the class of 1909, who went overseas with the 169th Battalion, has reverted to the rank of lieutenant for service in France with the 20th Battalion. He had previously been attached to the headquarters staff at Shorncliffe, England.

Major A. P. LINTON, a student of mechanical engineering, class of 1906, University of Toronto, crossed to France with the 1st Pioneer Battalion, which later became the 9th Canadian Railway Troop. Major Linton enlisted as captain and has recently received his promotion.

Lieut. J. MURRAY ROBERTSON, B.A.Sc., 1914, a brother of Capt. A. R. Robertson, who went overseas with the 14th Battery, C.F.A., has seen service on many fronts. He went over as sergeant but was given a commission in the Royal Field Artillery. He is at present in Palestine.

Lieut. HAROLD H. VROOM, B.Sc., a member of the class of 1910 of McGill University, has had an invention, the Vroom hydrophone, accepted by the British Admiralty. He enlisted in 1916 as sub-lieutenant in the Motor Patrol service, was promoted to the rank of sub-lieutenant in 1917, and is now in the British Naval Service.

Major E. R. BIRCHARD, a B.A.Sc. of the class of 1909, University of Toronto, enlisted in Toronto with the rank of sergeant-major in the Eaton Machine Gun Battery, 2nd Contingent. He crossed to England as lieutenant with this unit, but transferred to the 4th Division Supply Column, C.E.F., for service in France. He was later promoted captain, and in January of last year became C.O. of this division.

SIR JOHN WOLFE BARRY

Death has claimed Sir John Wolfe Barry. He died in London, England, January 22nd. He was born in 1836 and during his illustrious engineering career was connected with numerous important engineering projects. He was appointed by the British government on the Royal Commission on Irish Public Works (1886) and on the Western (Scottish) Highlands and Islands Commission (1889). He was connected with numerous engineering and allied societies, member of the Army Railway Council and consulting engineer to many railway and public works corporations. He was also author of several engineering text books, among them being "Railway Appliances" and "Details of Railway Construction."

FOURTH ANNUAL CONFERENCE ON ROAD CONSTRUCTION

The fourth annual conference on road construction for county road superintendents and engineers will be held in the Parliament Buildings, Toronto, February 25th to 28th, inclusive.

These conferences, which have been held during the past three years, have proved very practical, as they enable those concerned with the design, construction and maintenance of roads throughout the province to meet and discuss various phases of highway work. Problems are brought before many minds trained along the same lines and the general discussions result in the birth of new ideas and the adjustment of old ones, and altogether the conferences have been helpful to all those who have had the privilege of attending them.

In the past the practice has been to have the various subjects on the program introduced by short addresses from engineers connected with the Ontario Department of Public Highways, under whose auspices the conference is held. This year a change has been made and some of the subjects for discussion will be introduced by the superintendents and county engineers.

Many of the papers will be illustrated by lantern slides.

Inasmuch as the 16th annual meeting of the Ontario Good Roads Association will be held in Toronto on February 27th, 28th and 29th, it will be possible for the superintendents and engineers who come to Toronto for the conference on road construction to also attend the last three sessions of the Ontario Good Roads Association meeting. The program for the conference follows:—

Monday, February 25th

Morning Session: 10.30 a.m.—Introductory address by the Hon. F. G. Macdiarmid, Minister of Public Works and Highways. 11.00 a.m.—"Municipal Drainage as Related to Highway Construction," by G. R. Marston, C.E., Simcoe, Norfolk County engineer and road superintendent.

Afternoon Session: 2.00 p.m.—"Gravel Road Construction in Middlesex County," by C. Talbot, London, Middlesex County engineer and road superintendent. 3.30 p.m.—"Ontario Highway Laws," by W. A. McLean, Mem.Can.Soc.C.E., Toronto, Deputy Minister of Highways.

Tuesday, February 26th

Morning Session: 9.00 a.m.—"Legal and Engineering Features of the Elimination of Grade Crossings," by E. R. Blackwell, C.E., M.Can.Soc.C.E., Brockville, Leeds and Grenville county engineer and road superintendent. 11.00 a.m.—"Better Bridges and Culverts," by A. Sedgewick, Toronto, assistant engineer, Department of Public Highways.

Afternoon Session: 2.00 p.m.—"Bituminous Surfaces in York County," by E. A. James, C.E. (Tor.), M.Can. Soc.C.E., Toronto, engineer to the Board of Highway Commissioners, York. 3.30 p.m.—"Heavy Grading of Earth Roads in Lincoln County," by P. Robertson, Beamsville, Lincoln County road superintendent.

Wednesday, February 27th

9.30 a.m.—"Preliminary Work on Provincial Highways," Geo. Hogarth, O.L.S., Assoc.Mem.Can.Soc. C.E., Toronto, engineer of highways, Department of Public Highways. 11.00 a.m.—"Clay Road Maintenance

in Essex County," by J. F. Millen, Sandwich, acting county road superintendent, Essex County.

Afternoon Session: 2.00 p.m.—"Asphaltic Concrete Construction on Dundas Street, York County," by R. C. Muir, Toronto, assistant engineer, Department of Public Highways. 3.30 p.m.—"Macadam Road Construction in Frontenac County," by R. H. Fair, Kingston, Frontenac County engineer and road superintendent.

Thursday, February 28th

Morning Session: 9.00 a.m.—"County and Township Road Organization," by W. Huber, Toronto, assistant engineer, Department of Public Highways. 11.00 a.m.—"Concrete Road Construction," by T. Harry Jones, B.A.Sc., Brantford, Brantford city engineer.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS

(Continued from page 102)

gineers working at the front, especially at the Somme last year, where they had achieved the seemingly impossible in securing supplies for the advancing armies as they broke through the German lines, even bringing fire engines from London to pump water for the men and horses.

Brigadier-General Sir Alexander Bertram then spoke. "We are met here as engineers," said General Bertram, "on a historic occasion, to pay a tribute of respect and offer a few words of silent prayer for our gallant men who have volunteered and paid their sacrifices that our country and Empire might be free. We have lost many of our most promising young men, men who, but for the war, might have become prominent in their profession.

"We cannot all follow their example, but it is for us as engineers to do our share at home, and lead the way in developing our natural resources, improving our water powers and railways, and in other ways ensuring that this Dominion shall become the great nation they have fought, and are fighting, to make it. To do this, we must make our country strong and wealthy. The jealousies created by this war will not die out for years to come, and we all must do our share in this campaign of preparedness at home. It is for those of our profession to carry on this work, with one idea in their minds—God bless our men, and God bless our country."

Capt. Duchastel read a message from Dr. Charles W. Hunt, secretary of the American Society of Civil Engineers, expressing regret that George H. Pegram, the president of that society could not be present at the unveiling, and saying, "We greet you in the name of our entire membership, including 1,000 officers in uniform. We are with you in the war until complete victory is achieved, and are looking forward to much closer union with our Canadian brothers after that time."

The president-elect, H. H. Vaughan, then gave a brief address, after which the ceremony concluded with the singing of the National Anthem.

Defends the Government

The discussion on the fuel problem was then resumed, with Vice-President Fairbairn in the chair. President-elect Vaughan asked whether the committee whose appointment had been requested of council ought to make definite recommendations to the government regarding what should be done in regard to the fuel supply. What should the government do that it is not doing? The use of fuel is dictated by ordinary economic conditions. If the recommendations made by the Research Council had been made eight or nine months ago, as he understood to be the case, the Finance Minister was justified in turning them down and refusing to undertake any expenditures not directly aiding the war. The fuel difficulties at that time had not yet reached a degree of severity warranting such expenditures. The situation now may be different and the recommendations should be placed before the Minister again. But are we satisfied that the establishment of a demonstration plant by the government is the proper course to pursue? Anybody could later establish other plants and flood the market with briquetted lignite so that nobody could make any profit on their investment. The only solution, thought Mr. Vaughan, would be for the government to take full charge of all the lignite development. But when suggesting that, we must remember that we would be asking a fatherly government to do things for us which in the past we have always believed should be done by individual effort.

Replying to Mr. Vaughan, R. A. Ross indulged in sarcasm. "This is a beautiful world," said Mr. Ross, where everything is alright and all methods now prevailing should be perpetuated. If private interests are to be injured, the public should always be allowed to suffer.

"No manufacturer is entitled to waste coal merely because he can afford to pay for it. I am not satisfied with the quality of coal I am getting, and it will be worse next year. The situation is going to be so acute, the government will have to do something to develop our energy resources on a big scale."

Walter J. Francis explained that in making his motion he did not expect the meeting to solve the problems the committee would have to study. "Don't tell the committee what to do; let them sail in and study. We should not be a burden on the United States in this great struggle by asking them to give us things which we may be able to develop for ourselves."

J. A. Jamieson reminded the meeting that study was essential in arriving at a solution for the fuel problem. There are many angles to the problem which do not meet the eye at first glance. For instance, grain vessels might bring much coal to Montreal if the loading and unloading appliances at ports were improved.

J. B. Challies objected to a suggestion by Mr. Ross that government engineers should not be appointed to the fuel committee. He thought the government engineers were the ones who had devoted the greatest amount of study to power and fuel problems and that it was to them that council must look for help. Mr. Ross hastened to explain that his suggestion had been merely in the interests of the government engineers themselves, as they might find embarrassment in their membership on that committee if the committee were to find it necessary to bring influence to bear upon the government.

Mr. Fairbairn thought that there was no chance of such embarrassment being caused. The committee would be a committee of council. It would have no direct dealings with the government. It would merely report back to council, and all council could do would be to memorialize the government.

Mr. White urged that the government engineers have places on the committee. They are the men who can help bring about quick action. The tales of suffering due to fuel shortage are harrowing even now. What will happen next year if Canada should get only half the tonnage which the United States allowed us this year?

Electricity for Domestic Heating

P. B. Motley advised the engineers to pay more attention to electricity for domestic heating. He said that he

has tried it all winter at his house, and that down to zero weather, 16 kw. heated the house. That meant about one-half watt per cubic foot, whereas most texts on the subject refer to 2 and 3 watts per cubic foot as the minimum required. At $25 to $30 per horse-power, electricity for heating equals coal at $15 to $16 a ton. If electricity can be secured for $12 or $15 per horse-power, it would be cheaper than coal, thought Mr. Motley. With the invention of better electrical heaters and with more care regarding the heat insulation of houses, electricity as a means of heating Canada's homes is not at all an impossibility. (Adjournment.)

New By-Laws Adopted

Vice-president Fairbairn took the chair at the last session of the annual meeting, at 10 o'clock Wednesday morning, only about thirty members being in attendance. The report of the scrutineers was as follows:—

New by-laws, 427 for, 13 against.

Change of name to Engineering Institute of Canada, 490 in favor, 109 against.

New vice-presidents elected, H. E. T. Haultain and R. F. Hayward.

New councillors elected, E. Brown, J. M. Robertson, D. H. McDougall, N. E. Brooks, John Murphy, P. Gillespie, L. A. Thornton and E. G. Matheson.

President-Elect Takes Chair

Mr. Fairbairn asked the new president, Henry Hague Vaughan, to take the chair. Mr. Vaughan said that he had been working for the past couple years as a member of the committee on society affairs, and he was glad that the society had adopted the changes and improvements recommended by that committee. Referring to the change in name and scope of the society's work, he said that he felt the responsibility of having been given the task of carrying out these changes, but felt very much honored by the election to the presidency. The present time is a difficult one in which to initiate any changes, said Mr. Vaughan, but, on the other hand, he believed that while business is dull is the time for the society to put its house in order, so that when the members get busier in more prosperous times to come, that their organization would have been perfected.

Mr. Vaughan asked whether there was any new or unfinished business to be considered by the meeting. Andrew F. Macallum, works commissioner of Ottawa, expressed his regret that James White had announced an intention to resign from council. He said that the Ottawa members would be disappointed in Mr. White's retirement from the council. Mr. White is the type of educated, energetic, upright and forceful member that is wanted on the council of an engineering society. His resignation would mean a loss to the society, said Mr. Macallum, so he desired to introduce a motion "that it be the sense of the meeting that Mr. White's resignation be not accepted."

Henry Holgate seconded the motion, supporting Mr. Macallum's remarks, but the president said that he thought the motion was irregular as Mr. White's resignation had not been received and council knew nothing of the matter officially. Mr. Macallum agreed to a change in his resolution by the addition of the qualifying clause, "if presented," after the word "resignation," and the motion was carried in that form. Objection was raised, however, upon the grounds that an impossible situation would arise if Mr. White should present his resignation to council and insist upon its acceptance, and if council had to refuse to meet his wishes on account of instructions from the annual meeting. Mr. White, unfortunately, was not present to state whether he would reconsider his decision. To obviate such a situation arising, the meeting agreed, with the consent of Mr. Macallum and Mr. Holgate, to withdraw the motion and to leave it to the incoming council to persuade Mr. White to continue his work with that body.

Upon the suggestion of W. J. Dick, the meeting sent greetings to a past president, Geo. A. Mountain, who is ill. Greetings were also sent to Col. Dennis.

THE REGISTRATION

The members who registered from outside of Montreal totalled 55, a falling off of 10 as compared with last year. The order of registration of the visiting members was as follows:—

Alexander Ferguson, Ottawa; T. U. Fairlie, Toronto; W. P. Copp, Neilsonville, P.Q.; G. H. Blanchet, Ottawa; Frank E. Sterns, St. Catharines, Ont.; Robt. H. Enham, Ottawa; Geo. Reakes, St. Lambert, P.Q.; L. G. Jost, Neilsonville, P.Q.; H. T. Routly, Toronto; A. Dick, Quebec; W. N. Cann, Quebec; J. W. Harkom, Melbourne, P.Q.

W. V. Taylor, Quebec; Ernest V. Mook, Peterboro; B. F. Haanel, Ottawa; S. D. Fawcett, Ottawa; F. de C. David, Winnipeg; W. W. Benny, Ottawa; Geo. R. Smith, Thetford Mines, P.Q.; E. V. Johnson, Ottawa; Hugh D. Lumsden, Orillia; F. G. Goodspeed, St. John, N.B.; G. Gordon Gale, Ottawa; J. B. Challies, Ottawa.

J. B. Harvey, Lyndhurst, Ont.; Geo. Hogarth, Toronto; M. Wolfe, Quebec; E. A. Stone, Kingston; James White, Ottawa; Geo. Kydd, Campbellford, Ont.; Peter Gillespie, Toronto; W. J. Dick, Ottawa; E. P. Goodwin, Baie Verte, N.B.; K. H. Smith, Halifax; P. H. Herren, East Angus, P.Q.; B. E. Norrish, Ottawa.

W. F. M. Bryce, Ottawa; S. E. Oliver, Quebec; Harry A. Paquette, Levis, P.Q.; A. F. Macallum, Ottawa; R. F. Uniacke, Ottawa; Wm. P. Anderson, Ottawa; T. Eardley Wilmot, Ottawa; P. LeCointe, Ottawa; R. D. L. Finch, Ottawa; R. W. Leonard, St. Catharines, Ont.; F. S. Small, Cedars, P.Q.; W. K. Greenwood, Orillia, Ont.

G. H. Forth, Belleville, Ont.; N. E. Brooks, Sherbrooke, P.Q.; E. W. Oliver, Toronto; F. A. Dallyn, Toronto; J. G. Sullivan, Winnipeg; H. E. T. Haultain, Toronto; A. V. Redmond, Cochrane, Ont.

(To be concluded in the next issue.)

AMERICAN SOCIETY ELECTS OFFICERS

Arthur Newell Talbot, professor of municipal and sanitary engineering of the University of Illinois, Urbana, Ill., was elected president of the American Society of Civil Engineers at the sixty-fifth annual meeting of the society held recently in New York. The retiring president, George H. Pegram, said in an address that "11 per cent. of the membership of the society is now in the army, and the number is rapidly increasing." The members of the society were shown one of the new divisions of the subway and were entertained at luncheon in an East River tunnel.

This week's issue of *The Canadian Engineer* is largely devoted to a report of the annual meeting of the Canadian Society of Civil Engineers. Owing to this it has been found necessary to defer the publication of "The Engineer's Library" until next week.

The Canadian Engineer

A weekly paper for Cauadian civil engineers and contractors

Expansion Joints and Traction Trusses, Quebec Bridge

Special Devices Providing for Changes in Length of Superstructure and Its Parts Under Varying Conditions of Erection, Temperature and Stress—Sliding Rail Expansion Joints Allow Motion of 17½ Inches between Suspended Span and Each Cantilever Arm

By ARCHIBALD JOHN MEYERS
Chief Draftsman, Board of Engineers, Quebec Bridge

IN all steel bridges of considerable span it is necessary to consider the effects upon the structure of changes in length of its component parts or members from varying temperatures and loads. Any lengthening or shortening, great or small, of a main member of a truss has a proportionate component effect on the distance between the truss reaction points. It is the general practice to provide for a change in these distances by the use of sliding or rolling joints, in which free and unhindered motion is allowed, except for the effect of friction. If such expansion joints are not provided, the truss reaction points become fixed in position, the lines of action of the reaction forces, from the weight of the structure and its superimposed loads, are no longer vertical, the supporting piers or abutments are compelled to resist end thrusts or pulls from the deforming structure and the effect of such end thrusts or pulls would not only have to be considered with regard to the piers and abutments, but the resulting stresses induced in the truss itself would have to be calculated and provision made for them.

In the case of a short, simple or cantilever span, it is usually only necessary to provide for a change in the centre to centre distance of the truss reaction points, and a change in the overall length of the floor system, any relative motion of the intermediate panel points of the trusses with reference to the bridge floor from differences of temperature or from varying stresses in the members of the truss or floor being too small to be considered. In the case of larger spans, however, it is necessary to examine the effects of this relative motion between the intermediate points of the trusses and the floor system, and to provide intermediate expansion joints for the bridge floor, in order to relieve the severe bending stresses which might otherwise be induced in the flanges of the transverse floorbeams, which form the connecting link between trusses and the bridge floor.

In addition to the secondary bending stresses, just mentioned, in the flanges of the floorbeams, these flanges have, in small spans, usually to resist the effect of longitudinal forces from a braked train or the pull on the track of the locomotive drivers and the rolling frictional resistance of the train following. In larger spans these longitudinal forces should be resisted by special transverse traction trusses in the plane of the floor system, the duty of which is to transfer these longitudinal forces to the bridge trusses and consequently relieve, to a great extent, the floorbeam flanges from resisting bending forces for which they are not well adapted and which, if necessary, they can only resist in a very uneconomical manner.

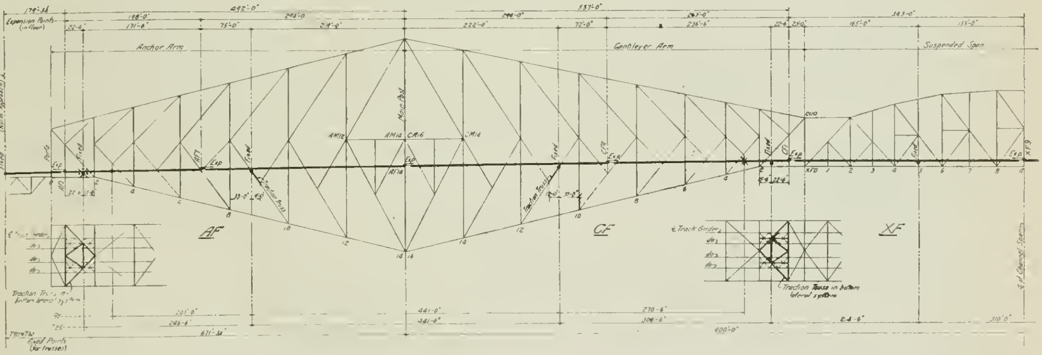


Fig. No. 1.—Elevation of Quebec Bridge Showing Location of Espansion Joints and Traction Trusses for Floor and Truss Systems

In the case of the Quebec Bridge, provision for change in length of the trusses of the main span—that is, the trusses of the cantilever arms and suspended span,—was made at the junction points between the cantilever arms and the suspended span. Provision for change in length of the floor and lateral systems of the main span was also made at the same points, but additional intermediate sliding joints, to accommodate the relative motion between the floor system and the bridge trusses, were provided in the bridge floor at the centre of the suspended span, at points directly over the main piers and at points about

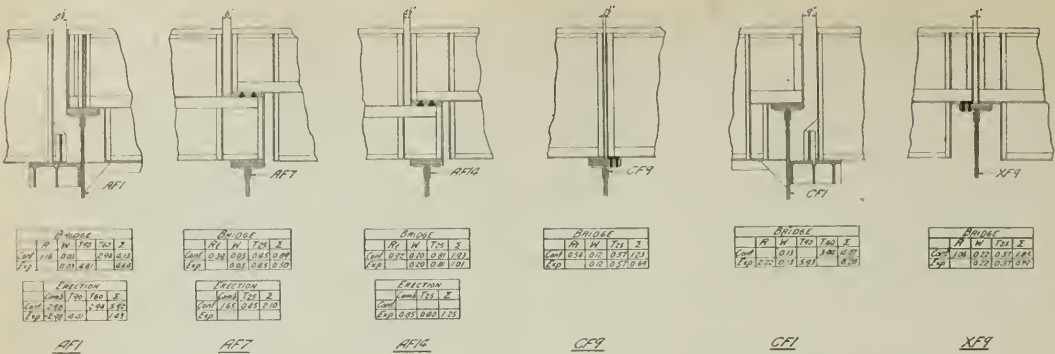


Fig. No. 2.—Expansion Joints for Track Girders at Main and Intermediate Panel Points

half-way between the main piers and the ends of the cantilever arms. For the anchor arms, provision for change in length of the anchor arm trusses and floor and lateral systems was made at the end of the anchor arms and intermediate sliding joints for the floor system were provided at points about half-way between the main piers and the ends of the anchor arms.

In order to properly transmit to the bridge trusses the longitudinal horizontal forces from moving live loads on the floor, each section of the floor, between sliding joints, was rigidly connected to the main bridge trusses by means of transverse traction trusses introduced in the sway and lateral bracing systems of the bridge. The positions of each traction truss and the adjacent sliding joints are shown in Fig. 1. They were interdependent and had to be so chosen so as to reduce as much as possible the bending stresses in the flanges of the main floorbeams. The positions of the fixed points were also governed to a large extent by the practicability of inserting a truss to connect the main bridge trusses with the floor system.

When the bridge floor was near the plane of the bottom laterals, as in the suspended span and along the horizontal bottom chords at the end of the cantilever and anchor arms, this was easily accomplished. The track girders were riveted to the bottom laterals at the points marked "fixed" in Fig. 1, and complete transverse trusses were introduced in the lateral system at these points by supplementing the bottom lateral members with additional members to form a complete truss system, designed to receive the horizontal longitudinal forces at the panel points and transmit these forces axially to the bottom chords of the main trusses. Midway between the ends of the cantilever and anchor arms and the main piers, inclined transverse trusses were introduced in the sway bracing for the compression diagonals which formed part of the sway bracing system. The track girders were riveted to the top chords of these trusses and delivered to them a diagonal component of the horizontal longitudinal forces acting on the floor. The vertical components necessary to balance these longitudinal horizontal forces were taken by the track girders and transferred to the main floorbeams, which in turn transferred them to the main bridge trusses.

As shown in Fig. 2, floorbeam XF9, the track girders of the suspended span are notched out at the ends, bringing

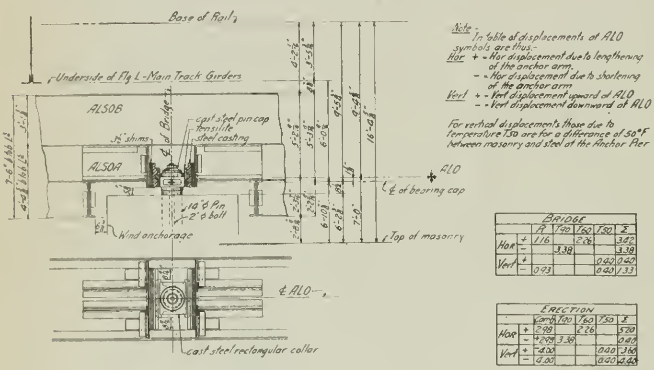
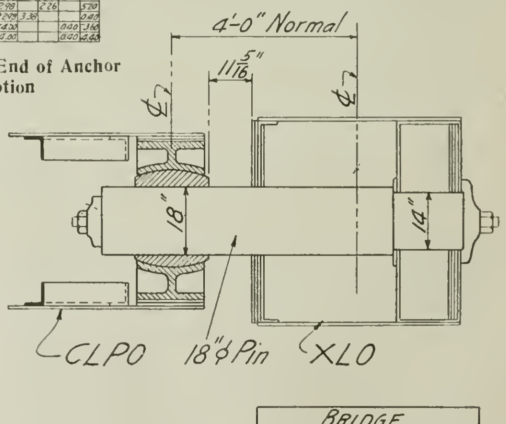


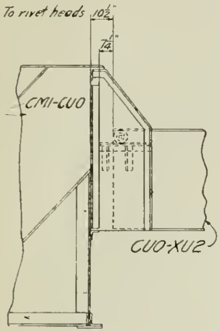
Fig. No. 3.—Expansion Joint for Bottom Lateral System at End of Anchor Arm, Providing for Both Vertical and Horizontal Motion



BRIDGE				
	R	T90	T60	Σ
Cont.			3.94	3.94
Exp.	2.22	5.93		8.15

Fig. No. 4.—Expansion Joint for Bottom Lateral System at Connection Point Between Cantilever Arm and Suspended Span, Providing for Relative Motion in Any Direction

the elevation of the bearings, on the top flanges of the main bridge floorbeams, about on the line of the neutral axis of the girders. For this reason the centre to centre distance of the floorbeam top flanges does not change under live load. The bottom chord, nickel-steel eyebars of the suspended span, with large unit stresses from live load, stretches considerably and in consequence the top flanges of the floorbeams are deflected, amounts which are practically in direct proportion to the distance of the floorbeams from the fixed points of the floor system or the points of location of the transverse trusses. In order to reduce this lateral deflection of the floorbeam flanges from this relative motion of the suspended span bottom chord panel points with reference to the floor system, to a minimum, the track girders were manufactured to such a length that the floorbeam flanges would be straight when the suspended span was carrying full dead load and a uniform distributed load equal to one-half the live load. The floorbeam flanges will therefore be deflected laterally equal amounts, opposite in sign, under full live load and with no live load on the span. Inasmuch as any floorbeam receives its maximum live load stress from engines placed directly over it, it could happen that at the same time the remainder of the span might be fully covered with live load or might have no live load at all. That is, any floorbeam may receive its maximum stress from vertical loads with full live load stress in the bottom chords of the span or with practically no live load stress in these chords. Therefore, by manufacturing the track girders in the shop so that the floorbeam flanges would be straight under dead load and a uniform distributed load on the span equal to one-half the live load, the lateral bending stress, co-existing with maximum live load stress in the floorbeam flanges, was reduced to a minimum. The track girders were erected after the suspended span was hoisted into place and when placing them the floorbeam flanges were given an initial deflection corresponding to the condition of no live load on the span.

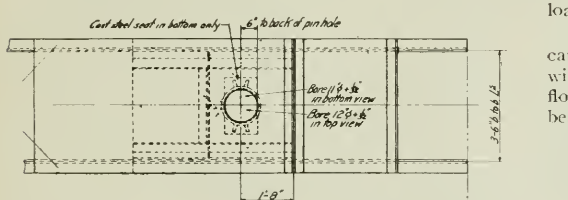


Bridge	R	W	T90	T60	Σ
Cont		0.23		3.94	4.17
Exp	2.46	0.23	5.93		8.62

Fig. No. 5.—Expansion Joint for Top Chords at Point of Connection Between Cantilever Arm and Suspended Span

The specification demanded that stresses arising from a difference of temperature of 25° Fahr. between the steel of the bridge trusses and the steel of the bridge floor must also be calculated and taken into consideration. The bending stresses in the flanges of the floorbeams from the relative motion of the suspended span bottom chord panel points with reference to the floor system, due to this assumed difference of temperature, was therefore calculated and considered as co-existing with maximum live load stress.

The bending stresses resulting from these several causes were considered as secondary stresses and were, with the adopted location of transverse trusses and sliding floor joints, too small to demand any increase of the floorbeam section required for the primary stresses.



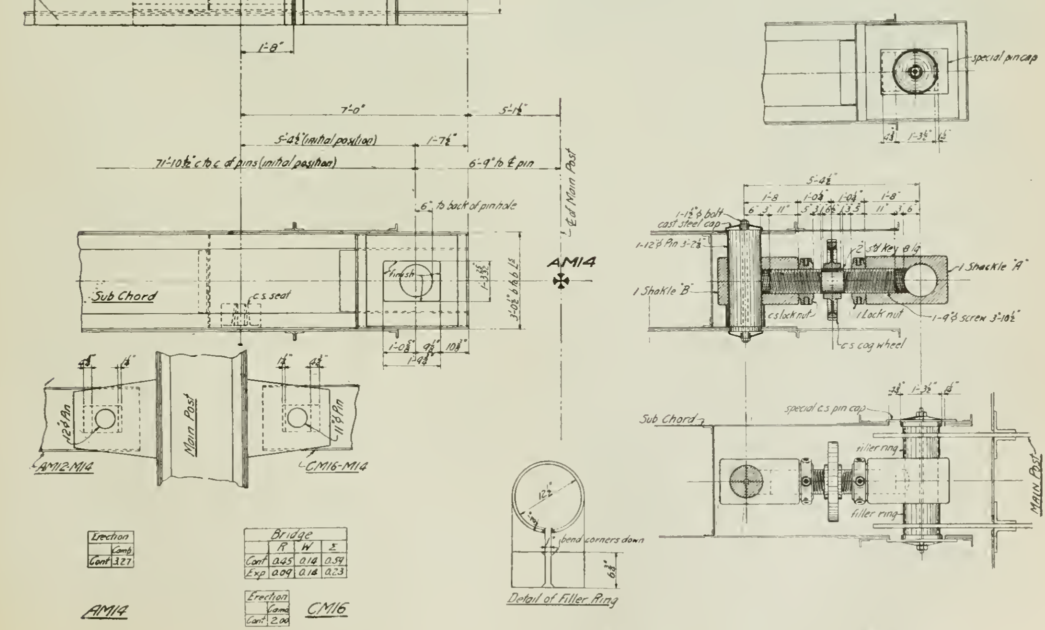


Fig. No. 6.—Adjustable Erection Joint Provided in Main Trusses at Panel Point AM14

Similar considerations for the cantilever and anchor arms governed the location of the sliding joints and transverse trusses to which the floor system was fixed. The floor system is there subdivided by sliding joints into sections of about equal lengths not exceeding 300 ft. and each section is provided with a transverse truss. Where the track girders are altogether above the floorbeams, with the bottom flanges riveted to the top flanges of the floorbeams, the moving load track girder flange stresses increase the centre to centre distance of the floorbeam flanges and this increase had to be taken into consideration when calculating the amount of expansion for which to provide. The relative motion of the cantilever and anchor arm truss panel points with reference to the floor system was obtained from Williot's displacement diagrams.

lower or tension flange of the main track girders while carrying live load where they rest on top of the main floorbeams. The deformations calculated on are based on an assumed average flange stress of 5,000 lbs. per square inch throughout the length indicated thus * in the diagram, Fig. 1.

W = displacements due to deformations in the truss members under a 30-lb. normal wind load.

T_{90} and T_{60} = displacements due to deformations under temperature. Expansions due to a shortening of the members under a tempera-

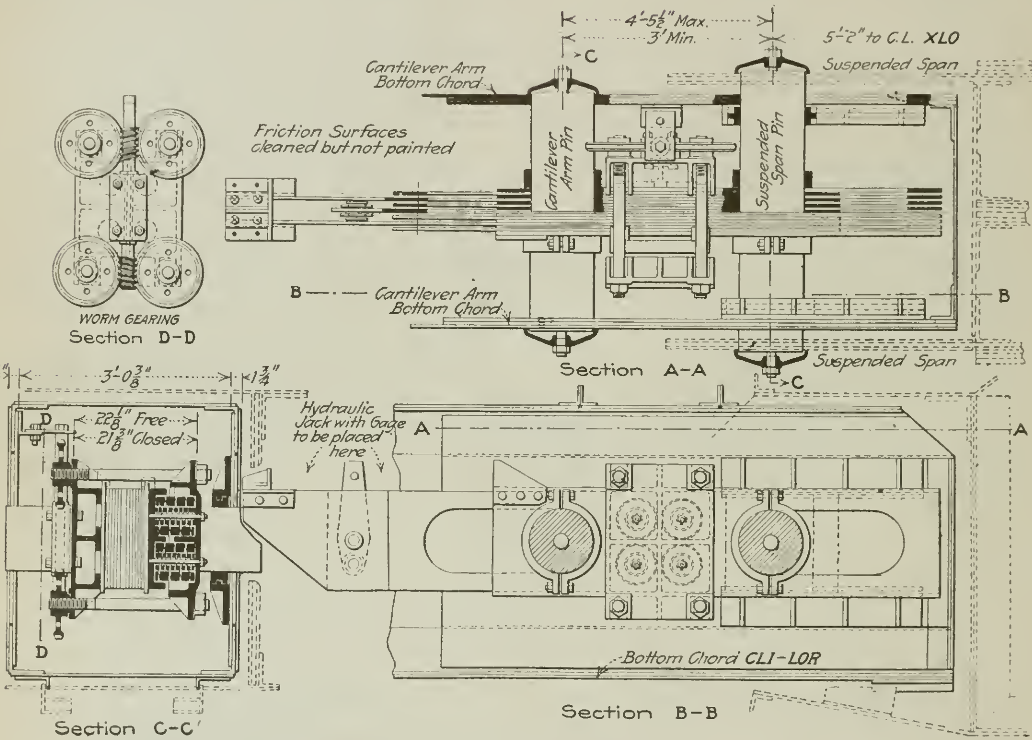


Fig. No. 7.—Traction Brake for the Suspended Span of the Quebec Bridge

The detail amounts which make up the total expansion and contraction provided at the various expansion points are given in the tables of Figs. 2 to 6, inclusive. The openings shown exist under normal conditions of temperature and loading. That is, with full live load on the cantilever arm and suspended span and a temperature of 60° Fahr. The terms "expansion" and "contraction" are used in the tables with reference to the expansion joints only. An expansion is an increase and a contraction is a decrease in the normal openings shown. The elements which appreciably affect the expansion joints are as noted in the tables for the various points and are represented by the symbols as follows:—

R = displacements due to deformations in the truss members under live load.

R_t = an allowance for the lengthening of the

ture variation of 90° Fahr. Contractions due to a lengthening of the members under a temperature variation of 60° Fahr. Normal temperature is assumed to be 60° Fahr.

T_{25} = displacements due to a temperature between the floor and truss of 25° Fahr.

Camb = displacements which occur during erection due to the initial shop camber of the members or to other erection camber adjustments.

Σ = the total displacement due to a combination of the above elements as noted at each point. The displacements are shown for both bridge and erection conditions.

(Continued on page 119)

THE SAINT AUGUSTIN-QUEBEC ROAD

By C. A. Mullen
Director of Paving Department, Milton Hersey Co., Ltd.

DURING the latter part of the nineteen-seventeen season, the Road Department of the Province of Quebec constructed slightly over one mile of mixed asphalt road surface. This was of the improved Topeka asphaltic concrete or stone-filled sheet asphalt variety, laid two inches thick upon the built-up old macadam roadbed of the highway leading out of Quebec City as the extension of Saint John Street. The present work began at the Quebec City line, and is to continue past Saint Foy and Ancienne Lorette to Saint Augustin, a distance of ten miles, where it will join the present macadam surface of the Quebec-Montreal highway, forming the necessary connecting link of good road.

When taken over by the Quebec Road Commission in the month of May, 1916, this section of old macadam highway was in a badly neglected state. Deep ruts and holes existed along its entire course, and certain parts were completely demolished by the action of frost and water due to a lack of ditching and drainage. The natural sub-soil was fairly firm, however, as the old turnpike trust had maintained the road in-a-way from year to year by adding broken stone to its surface. After the preliminary ditching and drainage work was executed, it was therefore decided to scarify the old roadbed, grade it up with a road machine and thoroughly compress it with a 12-ton road roller.

The results obtained were most gratifying. The new road presented a pleasing and uniform rolling surface very similar in appearance to new water-bound macadam construction. As this section of highway is the logical entrance to Quebec City from the direction of Montreal, it was at once subjected to an extremely heavy automobile traffic that had formerly sought the shortest way in by a longer way around. It then became apparent that a more permanent wearing surface was necessary; and, at the commission's request, their chief engineer prepared specifications for several kinds of wearing surface, bituminous macadam of both the penetration and mixed methods, asphaltic concrete of the improved Topeka or stone-filled sheet asphalt variety, and Portland cement concrete.

The different tenders received were carefully studied and, finally, on the advice of the chief engineer, the commission adopted the asphaltic concrete type. A price submitted by Laganiere, Houde & Company for this construction, when considered in relation to its desirability and general economy, was considered very favorable. The main points advanced as arguments for this type of pavement surface were durability, low cost of maintenance, dustlessness, and desirable rolling-surface for both automobile and horse-drawn traffic.

The contract was awarded to Laganiere, Houde & Co., of Grondines, Que., at approximately $14,000 per mile of road 16 feet wide; theirs being the lowest of several bids. The price included regulating and grading the old macadam, furnishing the necessary road metal and building up the old surface to a minimum thickness of 8 inches, and the 2-inch asphalt topping complete.

The foundation of the road was wet in some places, necessitating careful drainage. Culverts were built at many points, and tile used where required. At other places, the alignment of the road was straightened and many of the sharper curves are being banked to better accommodate automobile traffic. The weather record of this job to date is very bad, rain having fallen on seventy-two days out of a possible one hundred and forty days, and many of the others being very disadvantageous because of the condition of the ground. Asphalt was laid on only twenty-five days, many of which were unsuited for continuous operation and produced very small yardages.

Before building up the foundations, the road was thoroughly inspected a second time, especially in spots where tile and blind stone drains, outlets and culverts had been constructed; and during the progress of the work no wearing surface was laid until the foundation had again been thoroughly tested with a 12-ton road roller and found to be thoroughly compacted.

The wearing surface mixture was prepared in a Cummer portable road asphalt plant of 2,000 square yards per day rated capacity, having a twin-pug mill capable of handling a 1,000-lb. batch of material. The formula of manufacture originally set from the samples of materials secured before the work was in progress, called for 10 per cent. of pure asphalt cement, 10 per cent. pulverized stone-dust filler, 50 per cent. standard sand aggregate arrived at by mixing fine, medium and coarse grade sands in definite proportions at the drum elevator, and 30 per cent.

A View Along Road After Completion

fine stone chips of what is known as the ¼-inch commercial size. It was necessary, of course, to modify this original formula slightly from day to day, in the manner required to take care of the variations in the materials as delivered and approximate therewith the model mixture.

Imperial brand asphalt paving cement was used exclusively; though the specifications were open to other good materials and the contractor purchased where he saw fit. It was manufactured by the Imperial Oil Company, Limited, at their Montreal East refinery, from Mexican crudes, and had a consistency or penetration of between 58 and 62, and a ductility greater than 100. This material was sampled from the stills at the refinery and tested, and checked in actual use by samples taken at the asphalt mixing plant. It proved satisfactory at all times, the tests showing a uniform and suitable cement.

The pulverized stone-dust filler was furnished by the Stinson-Reeb Builders' Supply Company, of Montreal, who have a Griffin mill for the production of this material at their Outremont quarry.

Sand, of all three grades necessary to produce the standard type of sand aggregate for asphalt paving purposes, was found locally. The insistence of the provincial engineers that the contractor secure proper materials,

though it at first seemed a hardship to him, worked out very much to his benefit. By a little prospecting along the line of the work, sands were found that were entirely suitable, and that actually cost much less than that upon which the estimate had been based.

Stone chips were taken from the Vezina quarry, near the present plant site, and were of very good quality, both as to texture and sizing. Some of the crusher-dust was used in lieu of coarse sand, but only proved partly satisfactory; the difficulty being that the mixtures prepared with it carried too large a proportion of 10, 20 and 30 mesh particles. It was temporarily discontinued, but a different combination of sands might make its use again desirable.

The accompanying daily report of mixture analyses is quite representative of the entire work completed to date. Two samples were taken each day that the plant operated, and an examination of all the reports does not show any serious variations. Great care was exercised to see that there was always a high percentage of 200-mesh material present, and that the mixture carried all the bitumen possible without being too sloppy.

The model mixture shown in the report is substantially that of a standard sheet asphalt pavement to which stone chips have been added. If the material held on the 10-mesh sieve is eliminated, the balance of the mixture is a standard sheet asphalt, and the specifications shown are on the same basis. Neither the model mixture nor the specifications require the infringement of any patent; in fact, they distinctly prevent it.

Portable Asphalt Plant

The variations from the original formula of manufacture that may be noticed in the report were necessary for these causes: The stone-dust delivered was lower in the finer particles than the original sample, and it therefore required a larger proportion per batch to secure the required percentage of 200-mesh material in the mixture; and the sand carried enough grains that were held on the 10-mesh sieve to make it necessary to reduce the proportion from the stone-chip bin.

The contractors, Laganiere, Houde & Co., experienced considerable trouble at the beginning of operations. Several hundred square yards of the first few days' work had to be removed and replaced, principally because of the excessive heating at the plant and inexperienced labor on the road. Conditions soon began to improve, however, and though the progress in linear feet of roadway completed each day was not entirely satisfactory, the mixtures were uniformly good as regards the grading of the aggregates and the bitumen contents, and after the first few days the workmanship of the laying was of a very fair character, even when judged by severe standards.

A 16-foot straight-edge, sufficiently light in weight to be practical for easy handling, functioned constantly to check the surface longitudinally, and a template was employed for the cross-section. All the 1917 work was compressed with a three-wheeled macadam roller weighing about eight tons; but the resulting surface was not always satisfactory, and a regular tandem asphalt roller will be used this season.

The highway from Saint Augustin to Quebec was originally a toll road, and came under the jurisdiction of the Quebec Road Commission, which was appointed to

A Formula of Manufacture	Pounds	Per Cent	SAMPLE OF ASPHALT MIXTURE
Asphalt Cement	100	10	taken at mixer of plant of
Filler—Stone Dust	120	12	LAGANIERE, HOUDE & CO., ST. FOY,
Filler—Portland C'm't			by Mr. Abias Pepin, C. E.,
Sand from Collector			10:00 A.M., FRI., OCT. 12, 1917.
Sand from Heating Drum	570	57	Mixture going to surface
4 Mesh Stone Heating Drum / 2 Mesh Stone Heating Drum	210	21	SAINT AUGUSTINE - QUEBEC ROAD.
Total Batch of Mixture	1000	100	REMARKS: A very good mixture.

Test No. M-2560		Results of Tests of Sample Submitted				Model Mixture		Variations	Specifications Minimum	Specifications Maximum	Specifications Totals
Bitumen		10	2	10	2	10	10		8	12	
Passing	Held on	Note.—Figures show percentages by weight.									
200	Mesh	10	0	10	0	10	10		7	14	Not Less Than 18
100	200	16	3			9					
80	100	3	0	19	3	9	18		7	25	
50	80	11	3			16			3	25	11 to 36
40	50	11	1	22	4	7	23		3	18	
30	40	6	7			6			3	14	7 to 25
20	30	2	6			4			3	9	
10	20	5	2	14	5	2	12		2	6	
4	10	15	0			18			11	25	20 to 35
2	4	8	6	23	6	9	27		4	10	
	2								Penetration of Asphalt Cement	60	
Totals		100	0	100	0	100	100	Test run by G.			

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Sample of Report Forms Used by the Inspecting and Testing Engineers, St. Augustin-Quebec Road

take over and administer the toll roads around Quebec City, on May 1st, 1916. The chairman of the commission is Mr. Napoleon Drouin, ex-mayor of Quebec City, and the other members are Mr. Henri Laviqueur, mayor of Quebec City; Mr. Frank Carrel, president of the Quebec Automobile Club and president of "The Quebec Daily Telegraph"; Mr. Edmond Giroux, prefect of the County of Quebec. The secretary of the commission is Mr. G. H. Borroughs, the assistant secretary is Mr. Arthur Pigeon, and Mr. Ernest W. Gauvreau, C.E., is the chief engineer.

It is Mr. Gauvreau who designed and is directing the construction of this road. When the province of Quebec found it desirable to assist in its financing, and therefore took over the responsibility from the commission, Mr. Gauvreau was continued by the Provincial Road Department as engineer-in-charge, so that he now represents

both the Quebec Road Commission and the Road Department of the province of Quebec, of which Mr. J. A. Tessier is minister, Mr. B. Michaud, deputy minister, Mr. Gabriel Henry, C.E., chief engineer, and Mr. Alexander Fraser, C.E., principal assistant engineer. The burden of the work naturally falls upon Mr. Gauvreau, and much credit must be given to him for the quality and progress of the construction to date. The contractor could not have done so well were it not for his assistance, and he has been indefatigable in his endeavors to secure the best materials and workmanship available.

Before the asphalt topping was started, the minister of roads retained the Milton Hersey Company, Limited, to work with the engineers of the Provincial Road Department in connection with the mixing and laying of the asphalt wearing surface. Mr. Abias Pepin, C.E., was resident engineer-inspector for the Milton Hersey Company. Mr. A. Jacquemart, C.E., was engineer for the contractors, Messrs. Laganiere, Houde & Company.

ECONOMICS FOR ENGINEERS

ECONOMICS as an obligatory subject in engineering courses is recommended by the Committee on Economics of the American Society for the Promotion of Engineering Education in its recent report. As a result of a questionnaire to technical schools and of long interchange of opinion by letter and in meeting, the committee came unanimously to the following conclusions:

A knowledge of economics by engineering students, especially of the human element in industry and engineering work, is essential to greatest success in life. Former standards of technical perfection, having no regard to expense of construction, operation and service, no longer hold. Engineers have learned from experience how to work with inadequate facilities. They have had to meet new and trying conditions. Consequently attention has been given to the economic and social factors affecting engineering projects; and applied economics has had an extensive development.

Unfortunately, though, proper cognizance has not been taken of this important fundamental necessity when determining the details of the curricula in engineering schools. Young men have been left to learn what they can about the subject little by little after graduation—too often at the expense of those who pay for the constructions which they design and supervise. The opinion is general that the additional study of economics is a great and growing need in any educational plan.

The necessity of applying the principles of economics in engineering is generally recognized. Economics, therefore, should be an obligatory—not an optional—subject for engineers. The engineering student is likely to overestimate the value of the narrower and more technical features of his training, and to underestimate those things which help to give a broader view. The engineering schools in large part are preparing men for the position of leadership in engineering enterprise. For this a broad economic outlook is needed.

The committee does not now favor an economics course for freshmen. It is difficult even to find room for the subject in the sophomore year, already so overcrowded, although for some reasons it would be advantageous to start teaching it then. However, the commencement of the study of economics should not be later than the beginning of the junior year, so that an opportunity may be given to continue it into the senior year.

Engineering students should take both a course in the principles of economics, such as is given in the academic departments of the leading colleges and universities, and a course in the application of economics in engineering. Concerning the question as to which of the two should come first, there may be a division of opinion. The logical method appears to be that a course in the principles of the subject should precede, and be followed immediately by the special course in the application.

Furthermore, as an introduction to the general course, it is desirable that engineering students should be given in the sophomore year a thorough course in commercial or economic geography and industrial history.

In every practical course in engineering, *i.e.*, in all lines of technical activity which involve designing or construction, there should be given lessons in close detail upon the economics pertaining to the special branch of work. It is recognized that text-books suitable for such instruction do not yet exist; but the need might be met by a series of lectures. If the engineering teacher is not prepared himself, the school can seek and obtain the aid of specialists in the line of activity which he expounds.

Engineering instructors in all branches of the profession should possess a broad knowledge of the principles of economics. If any such teacher has not pursued this line of study, he would do well to avail himself of all opportunities to extend his knowledge.

A satisfactory course in the principles of economics would require at least a full year of three hours per week; and even this permits of a very brief treatment of many important questions. This is the shortest course which any engineering school should provide; but if in any case to do so is entirely impracticable, an earnest endeavor should be made to approach it as closely as possible.

It must be recognized that one of the great obstacles to the broader training of engineers is the limited time of the 4-year course. The range of subjects in both engineering and economics has extended so greatly that increasing difficulty is found in attempting to include them now in a 4-year course.

The program provides for four distinct types of instruction: (1) Preliminary study in commercial geography and industrial history; (2) fundamental course in principles of economics; (3) application of principles to engineering; (4) lessons upon special application in detail engineering work.

The committee recommended that, after a discussion of its report and the adoption of a program by the society, a new committee be appointed to prepare a definite content and scope of the courses, to be followed by a statement of the curricula and syllabus, in order to provide for putting into effect such courses as may be adopted by the society.

The committee submitting the above report consisted of J. A. L. Waddell, chairman; M. E. Cooley, F. L. Fetter and Morris Knowles.

The Sewerage and Public Works Commission of Guelph, Ont., at its regular meeting recently received the following report of City Engineer McArthur on the work of the Commission during the past year. The sum of $14,500 was appropriated by the city council for the current expenditure under the direction of the Sewerage and Public Works Commission, and this sum was later augmented by $2,500, making a total of $17,000. The total amount expended was $16,990.78. Of this amount, $483.63 was required for cleaning, flushing and repairing sewers; $3,520.37 was required for the sewage disposal plant; $8,988.68 was spent under the board of works account, exclusive of that laid out in actual street repairs. This leaves only the sum of $3,994.90 which was actually spent for repairs and maintenance of highways.

HYDRO-ELECTRIC DEVELOPMENT*

By Calvert Townley
Member of Engineering Council, Fellow A.I.E.E.

It is my pleasant duty to appear before you by vote of the Executive Committee of Engineering Council, in response to your kind invitation of January 10th. Being empowered as it is to speak for the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers on matters of common concern to all of these bodies, Engineering Council's official utterances concern only such underlying principles and economic facts as are endorsed by all engineers and beyond the field of controversy. These societies are scientific and professional. They, therefore, refrain from expressing views on legal, political and commercial questions except when such are closely linked with essential engineering facts. The statements which I am privileged to make to you are not expressions of my personal views nor of those of any group. They have been submitted to, and approved by, the Executive Committee of Engineering Council, which believes them to fall within the definition given.

The introduction of electricity as a means for transmitting power over considerable distances and its subsequent rapid development completely changed the status of hydraulic power. Previously, such power could only be used near falling water. Now it is commercially available in convenient form within a radius, in some instances, up to 200 miles, a fact that has made it possible to utilize water powers even when located in remote and inaccessible places. Indeed, to-day practically all hydraulic power developments of any magnitude are hydro-electric. Along with improvements in the art of electrical transmission have come equally rapid developments in the application of electricity. Electric light has become almost the universal illuminant. Electric motors largely drive our factories and propel all our street cars. They have made substantial progress in replacing steam locomotives on some large railroads, while the manufacture of nitrogenous products for explosives and fertilizers, and of such products as abrasives and aluminum, depends for its commercial success on electro-chemistry. In an endeavor to supply the demand for electric current thus created large central generating stations have been established in or near all large centres of population.

In the light of the foregoing, it might seem reasonable to suppose that a large proportion of the modern demand for electric current would be supplied from the energy in falling water. Such, however, is not the case. Accurate statistics are difficult to obtain but some approximate totals may prove illuminating. It has been estimated by a careful engineer that in 1911 there were over 26,000,000 steam engine horse-power capacity in use (including railroad locomotives) in the United States. The aggregate water horse-power developed and undeveloped has been computed as around 60,000,000. Of this latter the United States census of 1912 gives 4,870,000 as developed, and in a report of January, 1916, the secretary of agriculture estimates this total to have been increased to 6,500,000. Making liberal allowances for correction in these several figures, it seems probable that there are in service from four to five times as many steam as water horse-power and that there are still undeveloped water horse-power equal to at least twice that of all the steam capacity in service. Some of the undeveloped power sites are too remote from any market to be now utilized, and an uncertain number are not commercial prospects; but even so, it is clear that the possibilities of additional development are very great.

There are two fundamental causes which have militated against the substitution of hydro-electric for steam-electric power. One is economic and permanent; the other is statutory and therefore subject to modification. Both reasons apply to some powers but neither, fortunately, to all. The economic and permanent reason is high cost of development due to natural conditions. Electric power generated by falling water is inferior to that generated by steam in every particular except cost, and therefore water-driven service must be cheaper than steam-driven in order to justify its existence. The price for service depends primarily on cost, and cost divides itself naturally into two main items, namely, operation (including maintenance), and fixed charges. As an hydro-electric plant consumes no fuel, its operating cost is less than that of an equivalent steam-driven plant. On the other hand, a steam plant costs usually only from one-fifth to one-half as much per unit of capacity as an hydro-electric plant, so that the latter must carry very much heavier fixed charges. This disability of water service is usually even greater than the ratio of the costs of two equivalent complete developments. A power enterprise seldom comes into being with a market for its entire ultimate output. Therefore, when steam is to be the motive power, only such capacity is installed as initial demands require and the cost per unit is fairly proportional to that of the ultimate development. In a water development, on the contrary, a large part of the cost is for riparian rights, for the dam, impounding reservoir, flume, forebay, etc., and for the transmission right-of-way, towers, etc., which must be at the start largely provided and constructed for the complete installation. The obvious result is a greater fixed charge per unit of capacity and a higher cost per horse-power delivered for sale. In forecasting the commercial prospects of a power enterprise the possible market must be studied and, of course, a sale price for power decided upon. As this price is controlled by the cost of similar service from other sources, usually from steam, and as it must be attractive from the start, the additional burden of fixed charges on the initial part of an hydro-electric installation frequently forces the sale of its power below cost. The projectors of the enterprise then must rely for success on a sufficient subsequent increase in their markets. The possibility of an incorrect forecast of the extent of such increase and of the time when it may come imposes a serious business hazard against water and in favor of steam.

It has been frequently pointed out that as the nation's coal supply is depleted, the cost of coal must rise, thus increasing the cost of steam-electric power as a competitor and raising the market value of hydro-electric power accordingly. The rising price of coal is a matter of record, but it is not so generally known that the improved efficiency of steam-producing machinery (boilers, engines, generators and auxiliaries) has more than kept pace, so that the net cost of producing electric power from coal has steadily declined. As applied to the pre-war period, it may be stated that over a period of ten years the cost of coal has risen on an average 1 per cent. per year while the cost of electric power produced from coal has fallen on an average 2½ per cent. per year. In addition to these facts—still referring to pre-war conditions—the cost of steam-electric generating equipment has been greatly re-

*Prepared and presented on the special invitation of the Water Power Committee of the United States Chamber of Commerce.

duced. This fact is due partly to the introduction and subsequent improvement of the steam turbine, and in part to the great increase in the size of the units now available. There is nothing to indicate that the limit of improvement in the design of steam prime movers has been reached or is even in sight. It is, therefore, a reasonable assumption that further advances in the art will continue to occur and to cut down both the fixed charges and the operating cost of steam power as a competitor of water. The largest modern steam turbine has now some twelve times the capacity which the largest reciprocating engine had fifteen years ago. Stated another way, the cost of a steam-electric plant per unit of capacity just before the war was about one-third what it was fifteen years previous, while the energy it produces per pound of coal has increased 50 per cent. In addition to the development of steam prime movers, the Diesel or the internal combustion engine is now coming largely into use as a further competitor of water power where fuel oil is available as in the south-western district of the United States. The efficiency of these engines is considerably higher than that of the small size steam turbine and reciprocating engine. There has not been a like improvement in the efficiency nor a comparable reduction in cost of the small reciprocating steam unit and a natural result has been expansion of the central stations. As bearing on the water power situation, obviously many sites which fifteen years ago might have been developed to sell energy in successful competition with steam at its then cost could not now be so developed, and in consequence their development is no longer commercially possible. The cost of producing power from either water or steam is a function of load. Fixed charges remain practically unchanged in both instances where the output in energy be large or small, but with a steam plant, increased output means increased fuel consumption, while a water plant operates either with or without load with but little variation in expense. To illustrate by a concrete example representing not unusual conditions, suppose we assume a steam plant using 2½ pounds of coal per kilowatt-hour at a price of $3 per short ton and having a plant or output factor of 35 per cent.—that is to say, an output equal to 35 per cent. of its theoretical output if every unit were loaded to capacity 24 hours each day of the year. Under these assumptions the cost of fuel per unit of installed capacity per year would be $11.50 and if the other operating and maintenance charge be assumed to fairly offset those of a water installation of equivalent size $11.50 represents the additional fixed charges which the hydro-electric plant could carry and produce power at an equal cost. If the fixed charges (interest, taxes, insurance and amortization) total 11½ per cent., therefore, the hydro-electric investment per kilowatt capacity could exceed that of steam by $100. This is not an abnormal excess. Many hydro-electric developments exceed the cost of equivalent steam-driven systems by much greater amounts, in which cases they become commercial prospects only if either coal be more expensive per unit of output, or the plant factor be higher, or some other operating or maintenance condition be more favorable. Further, as has been previously stated, hydro-electric power is inferior to steam-electric power. The reasons are elementary. Stream flow is subject to seasonal variation, and therefore to complete or partial interruption by drought in summer and by ice in winter. Floods are a menace. Long transmission lines may break from wind or sleet or the service be disarranged by lightning. The losses on such lines vary with load and are frequently responsible for annoying pressure variations. On account of these and other reasons hydro-electric power cannot prevail against steam competition at the same or a slightly lower price. It must be materially lower.

We do not mean to imply that water power may not be a commercially practicable competitor of steam. Many successful hydro-electric installations give substantial proof to the contrary. We do wish most emphatically to combat, however, the widely held but mistaken view that any water-driven plant will produce power at lower cost than steam can, and that the margin is so large investors generally are eagerly seeking a chance to put money into hydro-electric projects. The most careful investigation, frequently demanding substantial expenditure and the keenest scrutiny by experts, is needed to discriminate between worthy and commercially impractical projects, and the difference is often so small that the imposition of even what seem to be minor burdens is sufficient to turn the scale in favor of steam and entirely prevent what might otherwise be a desirable hydro-electric development.

The second condition which vitally affects development is statutory. After ten years or more of discussion it has come to be generally agreed that our Federal laws discourage the development of a large proportion of the nation's water powers and remedial legislation has been considered at every session of Congress for many years. The legal obstacles are quite distinct and separate from the economic facts which have been previously described and are in addition thereto.

Of the estimated 55,000,000 undeveloped water horse-power in the entire country, approximately 40,000,000 is located within the boundaries of the thirteen so-called western water power States. In these same States the Federal Government still retains as proprietor 760,000,000 acres, or over two-thirds of the aggregate acreage of all these States taken together. In order to develop power in that section it is therefore nearly always necessary to use some part of this public domain if not for the dam site itself, at least for flowage, for transmission right-of-way or for some other purpose. Existing law forbids such use except under permit issued by the secretary of the Interior and revocable without cause, at any time, by himself or his successor in office. It was once believed that revocation would only follow gross abuse well-established by evidence, but the drastic action of a one-time secretary of the Interior some years since to the contrary, disabused investors of this confidence and demonstrated by a sad object lesson the insecure tenure afforded by existing law. As funds for hydro-electric development must come from private sources, the unstable tenure imposed by this condition has constituted so great a hazard of loss that the private investor has been loath to assume it. The unfortunate—almost disastrous—result has been practical stagnation in water power development for many years. Many available power sites not in the western States, or not on the public domain, are on navigable streams. For such project a special Act of Congress is necessary. The difficulty of obtaining suitable rights by this means has been found so very great as largely to discourage, even if not entirely to prevent, the developments affected. The several remedial laws recently considered by Congress recognize the essential facts and agree that the remedy is a new law containing the following provisions, namely: An indeterminate permit irrevocable during fifty years except for cause judiciously determined, and continuing thereafter unless and until the Federal Government either renews its permit on mutually agreeable terms, or for itself or through a new permittee takes over at its fair value, the hydraulic works and certain other parts of the development. The various proposed laws differ as to what parts of the development may be taken; as to whether or

not rentals shall be paid and their basis, and in many other particulars. Engineering Council does not consider itself expert in legal matters and will not undertake to discuss the relative merits of the different plans. It should be pointed out, however, that an hydro-electric enterprise being once successfully established, it is alike to the interest of the owners, of the government, and of the public that it should continue indefinitely without interruption. There is no economic reason to be served by a cessation, and the only reasons for providing a legal means of recapturing the installation and the water rights are, first, to preserve an additional measure of government control against possible abuse by the permittee, and, second, against a remote contingency which might make it desirable that the government would want to use the power for some other purpose. A successful power enterprise at the end of fifty years will have multiplied the capacity of its initial installation many times, variously estimated at from five to twenty. In doing so, it is almost certain that not only will the entire power available at the original site be fully developed but other powers as well, which latter may or may not be dependent upon government permits. Still further, in nearly all cases steam plants as well as water plants are necessary. These steam plants are necessary to supplement hydro-electric power at periods of low water and in case of interruption, as well as in some instances to provide increased capacity. In fact, modern practice is rapidly approaching that of providing steam capacity equal to 100 per cent. of hydro-electric for the purposes stated. In any event, the growth of the enterprise over a term of years will be continuous and progressive. There will never come a time when it may be said to have been completed and subject to no further expansion. This continuing growth makes burdensome and usually abortive any attempt to amortize the investment, while the investment in other water powers or in steam plants, or both, interconnected with, and generally dependent for their economic operation on, the original development renders the right to recapture that development only very onerous and one which constitutes a serious impediment to the free and full development of an enterprise which is otherwise most desirable from all standpoints. With respect to power sites on the public domain and on navigable streams the government is in the position of seeking to have its resources developed without assuming any business hazard and without contributing either capital or credit. It would be unfortunate, in the light of past experience, if any new laws which may be enacted should put the government in the position of bargaining with capital and of offering just sufficient incentive not to induce capital to undertake the developments desired, thereby, while apparently providing a remedy, in reality insuring a continuance of the present undesirable condition. Hydro-electric enterprises must compete with the demands of other industries for capital. Experience has shown that even without the imposition of additional financial burdens many of them are not sufficiently attractive to secure development and as the attractive prospects grade by imperceptible degrees into the unattractive ones, it is perhaps self-evident that every additional burden, however small, transfers a percentage of such projects from commercial into uncommercial prospects. It is our belief that the benefits afforded the communities served by cheap power, and to the nation by the conservation of coal resulting from the substitution of a self-renewing for a non-renewable natural resource are far more valuable than is the exact solution of the question of restricting the returns to capital to their irreducible minimum. The present emergency due to the progress of the war has forcibly illustrated the importance of having developed the greatest possible number of water powers as a source of industrial power supply. As it consumes no fuel, the substitution of water for steam power would release to other uses all the extensive railroad and water facilities now engaged in transporting coal. It would similarly release a corresponding volume of labor now occupied in mining this coal and in operating such transportation agencies as well, and the boiler-room forces of the steam-power plants themselves.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, TORONTO SECTION

On the evening of January 18th the Toronto Section of the American Institute of Electrical Engineers listened to a most interesting paper on "Synchronous Motors," presented by Mr. M. J. McHenry. The paper dealt with the relative features of synchronous and induction motor plant and showed that where the consumer's rates were based on his power factor the extra cost of the synchronous plant would frequently soon be absorbed by the reduction in power charges. Mr. Percival H. Mitchell was in the chair.

THE FUEL VALUE OF WOOD*

It takes a cord and a half of short-leaf pine, hemlock, red gum, Douglas fir, sycamore, or soft maple, which weighs about 3,000 pounds a cord, to equal a ton of coal, while for cedar, redwood, poplar, catalpa, Norway pine, cypress, basswood, spruce, and white pine, two cords, weighing about 2,000 pounds each, are required. Weight for weight, however, there is very little difference between various species. Resin affords about twice as much heat as wood, so that resinous woods have a greater heat value per pound than non-resinous woods, and this increased value varies, of course, with the resin content. The available heat value of a cord of wood depends also on the amount of moisture present. When the wood is green part of the heat which it is capable of yielding is taken up in evaporating the water. The more water in the wood the more heat is lost.

Furthermore, cords vary as to the amount of solid wood they contain, even when they are of the standard dimension and occupy 128 cubic feet of space. A certain proportion of this space is made up of air spaces between the sticks, and this air space may be considerable in a cord of twisted, crooked, and knotty sticks. Out of the 128 cubic feet, a fair average of solid wood is about 80 cubic feet. This, however, applies to the standard cord, in which the sticks are cut to 4-foot lengths and piled 4 feet high and 8 feet long.

Hickory, of the non-resinous woods, has the highest fuel value per unit volume of wood, and has other advantages. It burns evenly and holds the heat. The oaks come next, followed by beech, birch, and maple. The white pines have a relatively low heat value per unit volume, but have other advantages. They ignite readily and gives out a quick, hot flame, but one that soon dies down. The same is true of gray birch or "white birch," as it is often called, in the regions in which it abounds. With the resinous pines a drawback is their oily, black smoke.

*From bulletin issued by the Forest Service, Washington, D.C.

The Engineer's Library

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer, 62 Church Street, Toronto.

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BOOK REVIEWS

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Steam Power Plant Engineering. By Prof. George F. Gebhardt. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. Fifth edition, 1917. 1,057 pages, 642 figures, 6 x 9 ins., cloth. Price, $4.00 net. (Reviewed by Prof. Robert W. Angus, University of Toronto.)

This very excellent work has had such a wide circulation (the total issue being fifteen thousand) that it is fairly well known to engineers and technical men. The author states that the present edition has been rewritten in order to keep up with the advances made in power plant equipment in recent years.

To deal with the book at all adequately would require more space than is available here, but the general subjects treated are fuels and combustion, boilers, smoke prevention and furnaces, superheaters, coal and ash handling machinery, stokers, chimneys, draft, engines, turbines, condensers, pumps, separators, piping, lubrication, testing, costs, etc., etc., and it will be seen that these cover the entire field of the power plant in a very complete manner.

Take, for example, the chapter on boilers. The various types are illustrated and described, with explanations as to the advantages of each type. This is followed by a discussion on the unit of evaporation and the transmission of heat through plates, with experimental data and formulas, the amount of heating surface required in different cases, and the calculation of boiler horse-power, with a numerical example. Then the necessary area of the grate surface is discussed, also boiler and furnace efficiency, with a numerical example, and much test data, and also boiler capacity.

The chapter on boilers also contains a number of curves giving the relation between efficiency and capacity under different circumstances, discussion on the most economical loads, the effect of the steam temperature and of the thickness of fire on the efficiency; formulas are also given for the cost of the boiler and setting, and a discussion of the selection of the best types. The chapter concludes with a description of details and mountings and a set of examples. In many places throughout the chapter references are given to articles bearing on the subjects treated, and the whole is well illustrated.

The chapter on boilers has been mentioned at length to show the nature of the book, this one chapter having been selected at random, and is similar to others. Thus the chapter on steam turbines contains 76 pages and in it are discussed the types of turbines, along with the general theory of each type and their possible efficiencies, the matter being illustrated by numerical examples. Much space is spent on the purpose of the turbine and the effect of various properties on the efficiency, curves from practice being used in many cases. This chapter has numerous references and some problems.

These two chapters are typical of the entire book, which covers the power plant and its machinery with much thoroughness. While the discussions are broad, they should be easily understood, and the book should commend itself to many classes of readers. There are nearly 650 illustrations.

To the engineer having to do with power plant machinery the book would be of very great value and assistance, and is fully up to date.

Microscopic Examination of Steel. By Henry Fay. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1917. 18 pages reading, 55 photographs, 6 x 9 ins., cloth. Price, $1.25 net. (Reviewed by J. W. Evans, president, Tivani Electric Steel Co., Limited, Belleville, Ont.)

In this book the author gives a clear account of the methods used by the Ordnance Department of the United States in preparing samples of steels for examination, a full description of the various grades of steels used, and photographs of the steels and numerous examples of imperfections disclosed by microscopic examinations.

The manner of preparing the specimens for examination with the microscope is fully explained, and some 55 micro photographs of steels and imperfections in steels are shown. The photographs are very clear, and one's only regret in reading the work is that more text is not given.

No mention is made of munition steels, and photographs of flaws and failures in shell steels would be a welcome addition to the work. The demand at present for flawless steels for ammunitions is so great, and the number of firms interested is so large that a work covering this branch of the subject would be most opportune. However, the author remarks in his preface that the work is not to be considered a text book on the subject, but rather an outline on the methods used by the United State Ordnance in their examination of gun steels.

We hope the author will include a study of ammunition steels and their faults in a future edition.

The work should be in every steel inspector's library, and will make a valuable addition to the libraries of those particularly in the steel industry.

The Development of Forest Law in America. By J. P. Kinney. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. 252 pages, 6 x 9 ins., cloth. Price, $2.50 net.

The Essentials of American Timber Law. By the same author and publishers. First edition, 1917. 279 pages, 6 x 9 ins., cloth. Price, $3.00 net. (Reviewed by R. H. Campbell, Director of the Forestry Branch, Ottawa.)

One is accustomed to hear of prominent public and business men who have prepared themselves for their final careers by the study or practice of the law, and to learn that the preliminary training in that profession contributed largely to their success in their later occupations. It would not be expected that there would be many instances of this in such a new profession as that of forestry, but prominence is given to at least one example of it by the almost simultaneous publication of two books dealing with the legal side of forestry and lumbering. The author of these, Mr. J. P. Kinney, has achieved a prominent place in the forestry profession as chief supervisor of the forests on Indian lands in the United States, and also holds a legal degree, so that he is well fitted to take up the subjects covered by these books.

The first book, on forest law, gives in the initial part of the volume an historical summary of the federal and state laws governing forest administration and fire prevention of interest mainly to the student of forest conditions south of the international boundary. The latter half of the book is of more general interest, since it outlines for a large number of subjects what legislative provisions have been made all over the United States to govern them. Subjects such as the disposal of slash, the requirement of permits for setting out fire in wooded districts, the regulation of the operation of locomotives so as to prevent fire, the encouragement of tree planting and of the rational handling of woodlands by private owners and municipalities, are of pressing importance in relation to the present development of forestry in Canada. The bird's-eye view of the experience of the United States in dealing with these matters in a legislative way which can be gained from this book is, therefore, of value to readers in this country.

The volume entitled "The Essentials of American Timber Law," is perhaps of wider interest since it deals with an extensive range of subjects connected not only with the growing and protection of timber, but with the harvesting of timber crops. The book, therefore, covers points of interest to every lumberman or business man whose interests are connected with timberlands or the products of trees. Trespass, injury to growing trees, contracts regarding growing timber, logging and the manufacture and sale of timber products, and the complex question of river driving are among the most important subjects dealt with in a comprehensive manner by the author. Of great value to the lay reader endeavoring to appreciate the legal point of view are the preliminary explanations in non-technical language of legal terms and principles with which each subject is introduced. Although the discussions are based mainly on American law, the explanations of general principles, no doubt, apply in many cases to English law as well, and in some instances the position taken by English law is specifically outlined. An insight into the legal aspect of the questions discussed can at least be secured through this volume by a man without legal training in a way that would not be possible in a book written in professional phraseology.

Practical Street Construction. By A. Prescott Folwell. Published by The Municipal Journal, 243 West 39th Street, New York City. 242 pages, 151 illustrations, 6 x 9 ins., cloth. Price, $2.00. (Reviewed by Thomas Adams, F.S.I., Hon. Mem. I.M. and C.E., Town Planning Adviser, Commission of Conservation, Ottawa.)

It is a revelation of the new thought on the subject of street construction that a book called "Practical Street Construction" should deal for the most part with street planning. Not that the title of the book published by the Municipal Journal and Engineer is a misnomer, for it proves that the practical and efficient construction of streets rests fundamentally on the proper planning of the alignment, width, grades and cross-sections of the street system of a city. The book should be studied by every municipal engineer and land surveyor.

One of the most instructive chapters is Chapter 1, which describes what streets are used for, and sets out no less than thirty-seven different uses, from that of carrying traffic to that of furnishing playgrounds for children. This long category of uses includes, of course, many which indicate the relationship of the street to the buildings fronting upon it, and the book goes a long way to show how intimate that relationship is. One or more chapters might have been added, however, to deal with the effect of height and density of building on street planning. To understand how a street system should be designed to secure the greatest convenience, and to effect the maximum of economy, one must look beyond the street and consider it with respect to the method of developing the building lots. The density, height and uses of buildings should be regulated to fit in with the street system as well as the street system to fit in with the character of building development. The authors of the book would render a still greater public service if they were to further elaborate this aspect of the subject in a sequel to the work under review. If this is done the importance of city or town planning will become even more evident than the authors admit it to be, and they will be able to find a solution for some of the difficulties referred to in the present work as impossible to overcome. For instance, the authors say that "it is impossible to foresee exactly the developments of the future in growth of business and traffic" and they suggest for this reason that it "is worth risking an increase of perhaps 10 per cent. to even 50 per cent. or more" over immediate requirements. But if a scheme of development defines the density and character of buildings, within certain broad limits, much greater accuracy can be obtained in defining the street system to suit that development than if building is left to chance and is entirely unregulated. For instance, in an English town-planning scheme the width of streets is determined to "suit growth of business and traffic," but the maximum density and heights of buildings in the area are fixed in the same scheme so that the engineer can anticipate the needs with an exactitude not otherwise possible.

The book also deals in separate chapters with planning street alignment, diagonal thoroughfares, street widths, sidewalk widths, minor residence streets, elastic streets, cross-sections, street grades, intersection grades, gutters, street and sidewalk obstructions, etc. Little attempt is made to treat of materials or methods of construction. There are over 150 appropriate illustrations.

Rules such as that in Ontario fixing a minimum of 66 feet for all streets are said by the author to be absurd. Most people who have studied the matter will agree. The 66-ft. width is wasteful where that width is too great for the requirements of traffic, and inadequate where that

width is too narrow for a main thoroughfare; while a standard width produces a stiff and monotonous appearance. We have this absurd system in vogue in most parts of Canada and no opportunity is given to the engineer to apply intelligent consideration to the requirements of each street.

Diagonal thoroughfares are shown to be of great value for the purposes of traffic distribution but where they are imposed on a rectangular lay-out they are only obtainable at exorbitant cost and after causing great waste of land.

The author indicates that streets should vary from 18 feet to accommodate two lines of traffic, to 120 feet for main thoroughfares with street railways. Every city has its special local problems to deal with, but as a principle no city should be tied down to a standard width for all purposes. Valuable suggestions are given regarding the difficult elements in designing hill-side streets and grade intersections on flat and undulating land.

Ingenieria de Ferrocarriles. By Verne Leroy Havens, M.Am.Soc.C.E. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. 1917 edition. 357 pages, 18 tables, 4½ x 7 ins., flexible leather. Price, $3.50 net. (Reviewed by Alfred S. L. Barnes, Hydro-Electric Power Commission of Ontario, Toronto.)

In this little book, written in Spanish, on railway engineering, the author, who is a member of the American Society of Civil Engineers and has evidently had a good deal of experience in South America, informs the reader that it has been prepared for the use of engineers who speak Spanish and for those who wish to acquire a knowledge of it. The sub-title of the book indicates that it deals with the fundamental theory and practice of railways, from the conception of the idea to the completion of the design.

In the introduction he points out that many Spanish-speaking engineers have had to learn a foreign language, in order to study, for want of the necessary books in Spanish, thus entailing double work for them. The book "has been written specially for those engineers who are going out from the universities and schools to-day" and who will take the places of the older engineers to-morrow.

Mr. Havens writes in a clear style and has arranged the various subjects treated of in the natural sequence.

In the earlier part of the book he discusses a matter in various aspects and then formulates a rule based on the premises and arguments just ahead and finally proceeds to apply the rule to a practical problem.

Several diagrams and tables are interspersed throughout the book and the last 100 pages consist of mathematical and other tables.

Some of the subjects covered may be indicated by the titles of the chapters: Chapter 1, Preliminary Commercial Considerations; Chapter 2, Valuation of Property; Chapter 3, Survey of the Route; Chapter 4, Organization and Equipment; Chapter 5, Preliminary Studies, Topography, Office Work; Chapter 6, Economic Problems; Chapter 7, Definite Schemes, Adjustment and Care of Instruments, Tables.

On page V. of the introduction in the ninth line of the third paragraph "los practico" should read "los practicos."

On page 5 in the last line "pra" appears instead of "para."

To the engineering students of South America, and to those engineers of other countries who have an idea of going there to take up active work of any kind, not necessarily in railway engineering only, this book will prove useful, as, while easy to read for anyone possessing some knowledge of the language, it will familiarize the reader with many technical words and phrases.

One unfortunate feature, which is only too common in other works as well, and which cannot fairly be blamed on the author, is the confusion of weights and measures arising from the use of both the Metric and English systems.

Business Law for Engineers. By C. Frank Allen, Boston. Published by the McGraw-Hill Book Co., Inc., New York, and the Hill Publishing Co., Limited, London. First edition, 1917. 6 x 9 ins., cloth. Price, $3.00. (Reviewed by A. F. Macallum, Commissioner of Works, Ottawa.)

The engineering profession will be interested in this book as the author is well qualified to deal with this subject. In addition to being an engineer of standing and a former professor of the Massachusetts Institute of Technology, he has a practical knowledge of law, acquired in the practice of that profession.

As Mr. Allen explains in the preface to his book, its purpose "is not 'to make every man his own lawyer,' but rather to give the engineer a knowledge of the fundamental features of law, so that he may have some idea of when or how to act himself, and when to seek expert advice, as well as to enlarge his horizon and perhaps to encourage him to a further study of law."

As a general rule, an engineer will be more likely to avoid legal entanglements if he seeks the advice of a qualified solicitor whenever he has to take action in a matter out of which a lawsuit may develop. The better engineer he is, the less likely he will be to trust to his own knowledge of the law in any difficulty where legal consequences of an important nature may develop. The number of members of the profession who can find opportunity to usefully add to their qualifications by acquiring a practical knowledge of another technical profession is necessarily limited. But cases arise in every engineer's experience in which some general knowledge of legal principles is involved. This book affords a convenient source of information in such cases.

It sometimes happens that an engineer has to decide promptly upon a course of action in the absence of qualified legal advice. His decision may have an important bearing upon the legal rights of either himself or of his employer. A general knowledge of the law will equip him to meet such difficulties. It may, indeed, frequently prevent him from proceeding along a course that would result in loss and litigation.

The book is divided into two parts. The first part consists of a general outline of the law. The author appears to have executed this part of his task in a very creditable manner.

The second part of the work deals with the subject of contract letting. The author discusses this subject step by step from the initiating advertisement calling for tenders, through the various steps which lead up to the execution of the formal contract. Incorporated in this part of the work are a number of useful forms which have been prepared by the American Railway Engineering Association, and by the American Institution of Architects. These standard forms have been prepared so as to provide, for almost every possible eventuality that may arise during the carrying out of an important engineering work and have apparently undergone the test of experience. They will be, doubtless, of great service to engineers when preparing their specifications and contracts.

Modern Underpinning: Development, Methods and Typical Examples. By L. White, C.E., and E. A. Prentis, Jr., E.M. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1917. 94 pages, 48 illustrations, 6 x 9 ins., cloth. Price, $1.50 net. (Reviewed by John V. Gray, John V. Gray Construction Co., Limited, Toronto.)

This book is largely a record of the methods adopted for the underpinning of the buildings adjacent to the subway excavations in New York City. It is a very readable volume, entirely descriptive in character, and should prove very suggestive to the engineer or contractor who is under the necessity of dealing with the conditions required in underpinning operations. The illustrations are excellent and have been well adapted to showing the character of the work described. Another marked feature in favor of the book is the fact that most of the statements contained in it are illustrated by descriptions of work actually performed on different types of buildings.

Chapter 1 contains extracts from the New York specifications covering the definition as to what constitutes underpinning and also as to the methods of payment there adopted.

Chapter 2, entitled "Development of Underpinning and Methods," states the successive steps of the development of the methods finally used, commencing with the simple system of shores originally developed for use with comparatively small and light buildings, and ending with a statement of the more complicated methods used in the case of very large and high buildings. Mention is also made of various methods of protecting the necessary excavations to avoid undue loss of earth. Attention is also called to the desirability of a thorough examination of the building itself before operations commence and of a written and photographic record of the defects then apparent as a means of checking any further defects due to the underpinning operations. The importance of this is, of course, apparent from the legal standpoint in the question of the settlement of damages.

Chapter 3, entitled "Preliminary Work," commences with a description of methods of shoring and needling and gives several good examples of work of this kind, showing how it was carried out in each case. This chapter describes foundations and foundation conditions generally and especially notes the desirability of the continuous foundation from the standpoint of underpinning operations. A very complete description is given of several methods of reinforcing foundations of the isolated pier type in order to make them continuous preliminary to underpinning operations proper.

Chapter 4, entitled "Underpinning Piers, Piles, and Wedging," is a description of methods of sinking pits, protecting the excavations, building piers, and wedging up the foundations from the tops of them. The description then passes on to steel or wrought iron pipe piling and methods of driving, mucking and concreting these piles, giving descriptions of hydraulic and compressed air apparatus used to drive them and transfer the foundation loads to them.

Chapter 5, entitled "Specific Examples of Underpinning," is a description of underpinning operations carried out adjoining the New York subway excavations in the case of eight different structures, showing examples of different methods adopted.

The appendix, entitled "Underpinning in Rock," states a few adaptations of the methods described in the previous chapters for use where building foundations are upon the insecure rock foundation, where the excavation must be carried down below the level of the bottom of the footing.

Altogether the book is a record of the special methods developed for the underpinning operations required in the excavations for the New York subways, and without a doubt as such is worthy of a place in the library of the engineer and contractor, all of whom at times have to deal with more or less intricate foundation conditions.

The Technical Analysis of Brass and the Non-Ferrous Alloys. By William B. Price, Chief Chemist and Metallurgist, Scoville Manufacturing Company, Waterbury, Conn., and Richard R. Meade, Consulting Chemical Engineer, Baltimore, Md. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. Second edition, 1917. 376 pages, 25 figures, tables, 5 x 7½ ins., cloth. Price, $3.00 net. (Reviewed by Robert Job, A.B., vice-president, Milton Hersey Co., Limited, Montreal.)

In preparing the second edition of this very useful book considerable of the text has been re-written in order to bring the text up to date and to include methods for the determination of the rarer elements such as vanadium, titanium and chromium, which are used to a considerable extent in modern alloys.

The introductory chapters give a general description of various industrial non-ferrous alloys, as for instance, bearing metal compositions, solders, etc., with a short statement regarding the properties and characteristics of the more important.

Electro-chemical analysis has been widely used in the determination of the non-ferrous elements, and in a special chapter in the book the various sources of current and the apparatus required in making the determinations is clearly stated. Also the advantages gained by use of the rotating anode are mentioned, and the use of compressed air as a stirring agent. The writer had occasion to experiment with this some years ago and found it very satisfactory in a number of the determinations.

Part II. is devoted to the determination of the principal elements, and standard methods of analysis are given in detail, although under "Phosphorus" no mention is made of the molybdate method.

Part III. gives "some applied examples of alloy analysis," such as the analysis of aluminum alloys, babbit metals of different types, pig copper, etc., and will well repay careful study.

Part IV. is devoted to "control and analysis of plating solutions," with general directions for use with various forms of plating.

The book closes with a table of atomic weights, factors, and a general index.

The work will be found very useful to the analyst and metallurgist. It is well printed and in convenient form, with good index, and is generally free from errors, although we note upon page 193 at the end of the eighteenth line the word "copper," which is evidently meant for "antimony."

PUBLICATIONS RECEIVED

Barrett Specification Roofs.—Illustrated catalogue published by the Barrett Company, 17 Battery Place, New York City.

Conservation in 1917.—Reprint from the ninth annual report of the Commission of Conservation, by Sir Clifford Sifton, chairman, Ottawa, 1918.

The Canada Year Book, 1916-17.—Edited by Ernest H. Godfrey, F.S.S. Published by the Census and Statistics Office, Ottawa, Ont.

Lloyd's Diagram for Calculations.—By H. G. Lloyd, A.C.G.I., M.Inst.C.E. Published by E. & F. N. Spon, Limited, London, Eng. Price, 2s. 6d. (60 cts.)

Rapid Sand Filtration.—Reprint from Journal of New England Water Works Association, by Geo. A. Johnson, consulting hydraulic engineer and sanitary expert, New York City.

Telephone Systems, 1917.—Extracts from report of Ontario Railway and Municipal Board for 1916 of statistical and other information relative to the construction and operation of telephone systems.

Technologic Papers of the Bureau of Standards.—Bulletin No. 95, issued by the Department of Commerce, Washington, D.C., treating with the durability of cement drain tile and concrete in alkali soils. Price, 35 cents.

Iron Ore Occurrences in Canada.—Describing the principal iron ore mines of Canada, accompanied by geological and magnetometric maps. Compiled by E. Lindeman, M.E., and L. L. Bolton, M.A., B.Sc. Issued by the Department of Mines, Ottawa.

Centrifugal Pumps and Centrifugal Pumping Units.—An illustrated pamphlet showing the various types of centrifugal pumps, the uses to which they may be put and instructions for their installation and operation. Published by the Canadian Allis-Chalmers, Limited, Toronto.

Turning Waste Into Profit.—This is the title of a 28-page booklet issued by the Prest-O-Lite Company, Inc., Toronto. It deals with the conservation of steel and iron by means of oxy-acetylene welding and cutting. Profusely illustrated, showing welding repairs. Mailed gratuitously.

Journal of the Engineers' Club of St. Louis.—A pamphlet giving several useful hints on road construction and power plant installations, with a preface on the training of engineers. Published by the Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo. Price, 35 cents per copy or $2.00 per year.

Triangulation of the Railway Belt of British Columbia. Issued by the Department of the Interior, Canada. Describing by diagrams and statistical tables the triangulation of the railway belt of British Columbia between Kootenay and Salmon Arm bases, from a survey by P. A. Carson, D.L.S., and M. P. Bridgland, D.L.S.

Carbonizing and Briquetting of Lignites.—Twenty-four page brochure by W. J. Dick, M.Sc., discussing the economic possibilities of marketing lignite. Issued by the Commission of Conservation, Canada, under the direction of the Committee on Minerals, Dr. Frank D. Adams, chairman. Mr. Dick, who is the mining engineer of the Commission, visited the lignite fields of Western Canada and thoroughly investigated the problem.

Pumps for Any Service.—An 84-page catalogue just issued by Darling Brothers, Limited, engineers and steam specialists, 120 Prince Street, Montreal. It describes in detail, both in illustrations and text, the many and varied lines of pumps and compressors manufactured by this firm. It also contains several pages dealing with important information for the benefit of intending purchasers of pumps.

The Saskatchewan Co-operative Elevator Company's new terminal elevator at Port Arthur, Ont., has been opened for the receipt of grain. The plant has a storage capacity of 2,500,000 bushels.

EXPANSION JOINTS AND TRACTION TRUSSES, QUEBEC BRIDGE

(Continued from page 108)

The intermediate floor expansion joints, as shown in Fig. 1, are located at panel points AF7, AF14, CF9 and XF9. At these points the expansion to be taken care of is that due to a difference of temperature of 25° between the trusses and the floor and relative motion of the truss panel points to the floor from changing axial unit stresses in the truss members or from varying flange stresses in the track girders of the floor system. At the point AF7 additional clearance had to be allowed on account of the camber of the anchor arm during erection. In order that the large connecting pins, varying from 10 ins. to 16 ins. in diameter, for the main members might be driven without fine adjustment of position, the pinholes in the top chord eyebars of the anchor arm were slotted one-half inch and the pinholes in the upper ends of the tension diagonals were slotted 2 ins. in the direction opposite to the bearing surface, and the bottom chords after being completely riveted up in a straight line were jacked down to a curve sufficient to bring the top chord panel points about 1 inch closer together than the normal shop lengths of the eyebars demanded. This avoided the necessity of frequent accurate adjustments of the length of the erection supports carrying the anchor arm trusses. These erection supports continually varied in length from changes of temperature and loads during the erection of the anchor arms. The shortening of the overall length of the top chord from this cause inclined the main post over the main pier towards the anchor arm about 14 ins. at the top of the post, and shortened the floor length between the main post and the anchor pier. This shortening was taken care of by the expansion joint at AF7. Erection camber consideration also influenced the amount of expansion provided at panel point AF14.

At the ends of the anchor arms the trusses do not rest on the anchor piers. The eyebars of the anchor chain are connected to the trusses at the upper end of the end compression diagonal and pass down through the shell covering of the end portal into wells in the anchor piers, connecting at the bottom of the wells to eyebar links embedded in the concrete of the anchor pier. These eyebar links connect in turn to anchorage grillage girders at the base of the anchor pier. The wells are 92 ft. deep, and the total length of free eyebar anchorage chain is 142 ft. The trusses of the anchor arms expand and contract from varying stresses and temperature to a total motion of 8½ ins. The eyebar chain is flexible enough to accommodate this motion without turning on the connecting pins and without creating bending stresses large enough to demand extra section in the chain itself. The steel plate shell of the portal around the anchorage chain is at all times free of the anchor pier and simply floats over the top of the anchorage well, serving as a protection to the chain and a cover for the well to keep out water.

The end strut of the bottom lateral system of the anchor arm is connected to the anchor pier at this point by a wind anchorage embedded in the masonry of the pier. The detail is shown in Fig. 3. A 14-in. diameter pin projects up from the wind anchorage and engages a sliding bearing located in the centre of the end strut. This bearing allows a longitudinal motion of ± 4¼ ins. from the normal position. The normal position is with full live load on the span between main piers and a temperature of 60° Fahr. This joint is also designed to allow a vertical motion due to the expansion and contraction of the anchorage chain from varying temperature and stresses

in the chain. The upper end of the 14-in. diameter wind anchorage pin is turned down to 12½ ins. diameter and a cast-steel rectangular shaped collar is held against the shoulder by a 2½-in. diameter through bolt and cast steel pin cap. The rectangular collar, in taking care of the vertical motion, slides vertically against a cast-steel retaining plate, which in turn takes care of the horizontal motion by sliding against a tensilite plate riveted to the bearing of the end strut. The cast-steel plate and the tensilite plate are held in vertical position relative to each other by a horizontal tongue and groove. The shims between the tensilite plate and the bearing of the end strut were for adjustment of position laterally and were necessary in order to be certain of making the connection after the bottom chords and lateral system were completely erected. This connection was designed to transmit the

The main floor expansion joints at the ends of the cantilever arms were located at CF1 (see Fig. 2), and were similar in detail to those at the ends of the anchor arms. The expansion connection for the cantilever arm bottom lateral system to the bottom laterals of the suspended span is shown in Fig. 4 and consisted of 18-in. diameter pin held rigidly in the end strut of the bottom laterals of the suspended span. This pin slides longitudinally in a ball-and-socket joint riveted into the end connection of the cantilever arm bottom laterals. The ball-and-socket joint allows turning both horizontally and vertically as the suspended span deflects in reverse curve to the deflection curve of the cantilever arm system, vertically for vertical loads and horizontally for wind loads. The 18-in. diameter pin is of nickel-steel. The socket casting is of cast-steel, and the ball casting is tensilite.

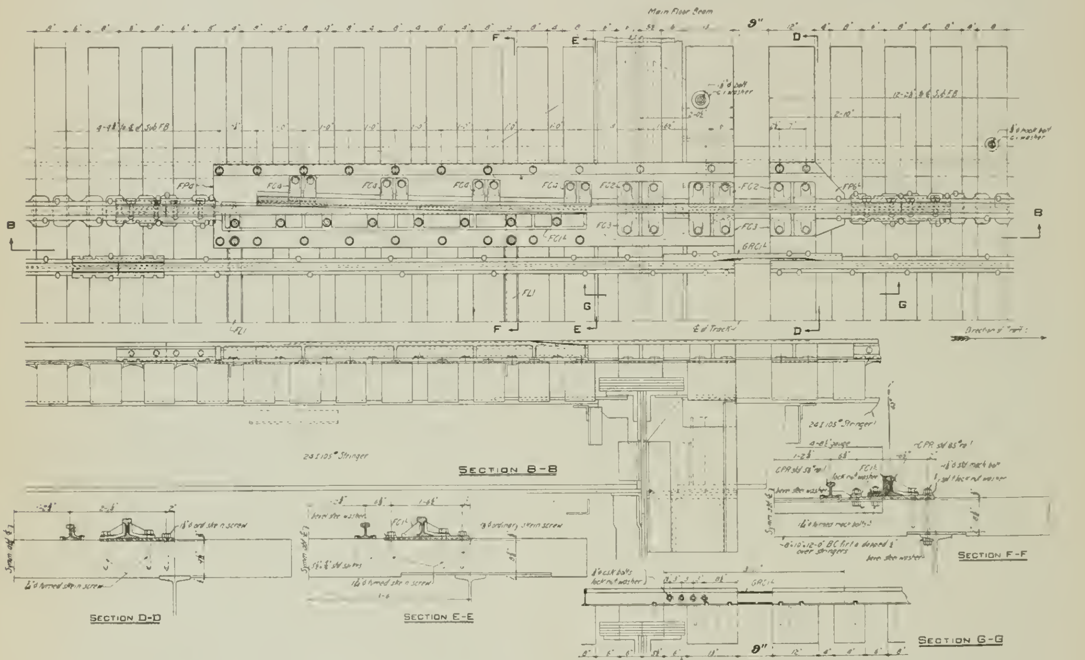

Fig. No. 8.—Main Rail Expansion Joint Provided in Floor System at Ends of Cantilever and Anchor Arms

end shear from the bottom lateral system to the anchor piers.

The detail for the expansion joint of the floor system was located at AF1. (See Fig. 2.) The track girders and track stringers of the end panel of the anchor arm were riveted to the top of the main bridge floorbeam while the track girders and track stringers for the approach span rested in bracket pockets riveted to the floorbeams and designed as small cantilevers with a tension connection across the top of the floorbeams to the anchor arm track girders and stringers. (See Fig. 8.) The sliding surfaces were a tensilite plate on a cast-steel base casting in the bracket pocket. This tensilite is a bronze compound with ultimate strength of $100,000 \frac{\text{lbs.}}{m^2}$ and elastic limit of $60,000 \frac{\text{lbs.}}{m^2}$.

These lateral connections at the ends of the cantilever system are about the only eccentric connections in the bridge and the eccentricity produces large bending stresses in the end struts of the suspended span bottom laterals and the anchor arm bottom laterals which, to a large extent, govern the general dimensions and sections of these struts.

A roller expansion joint (see Fig. 5) is also provided for the redundant member connecting the top chord of the suspended span to the top chord of the cantilever arm. This member is not a vital part of the truss system and serves merely as a foot-bridge link for the top chord.

For the main trusses a special expansion joint is provided between the suspended span and the cantilever arms. The total motion allowed for at these points for expansion and contraction is about 17 ins. at each end of the span, including an allowance of 2 ins. for error in placing the shoes of the main pier and in the overall manufactured length of

the cantilever trusses and the suspended span. The suspended span is hung from the ends of the cantilever arm top chords by a double chain of eyebars at each of the four corners of the span. These eyebar chains are 70 ft. long and connect to the suspended span at the ends of the bottom chords. In order to prevent any sudden movement of this span due to the application of the brakes to a train moving over it at a high rate of speed, it was thought advisable to apply a restraining influence to the maximum amount of traction force that could be applied at any one time—amounting to about 500,000 lbs. at each of the four corners.

To accomplish this result it was necessary to design an instrument which, while allowing the 17 ins. of motion, would be able to apply a resisting force to the traction at any point of this motion.

For this purpose what may be called a laminated friction brake was used. This brake, as shown in Fig. 7, is made up of a series of plates that slide between each other and are kept in contact by a set of car springs under a constant compression. Every alternate plate is fixed by a pin at one end to the horizontal piece of chord at the end of the cantilever arm and has a slotted hole at the other end to allow the necessary motion on the pin, which fixes the remaining sliding plates to the suspended span. These remaining plates are slotted in a similar manner, so as to allow the same amount of motion on the pin connecting the first-mentioned plates to the cantilever arm. Each brake is designed for a working resistance, to begin with, of 250,000 lbs. This force is developed by the friction between the 14 contact surfaces. Between each of the surfaces there must be developed a frictional resistance of $250,000 \times 1/14 = 18,000$ lbs. If we figure on a minimum coefficient of friction of 15 per cent. this will require that the plates be pressed together by a force of $18,000 \times 100/15 = 120,000$ lbs. To obtain a force of this amount, four double helical springs, each double spring having a capacity when closed of 38,000 lbs., are used for each brake. The outer coil is made up of 1 9/16-in. square and the inner coil of ¾-in. square steel. The springs have a height, closed, of 6¼ ins., and open of 7 ins.

The middle sliding plate is detailed so that the amount of frictional resistance can be ascertained by applying to it a small hydraulic jack with a gauge. The springs will be compressed by means of the worm gearing shown in the illustrations, until this middle plate develops a resistance to motion, as measured by the gauge, of 36,000 lbs., since the plate has two contact surfaces.

This brake force of 250,000 lbs. is constantly acting and the brake in constant motion, due to changing temperature and deformation of the trusses under moving loads. The contact surfaces will therefore wear to some extent, and the springs will also take a certain amount of permanent set under the constant compression acting. The effect will be to reduce partly the resistance of the brake, but the amount of this resistance can be tested from time to time by means of the jack and gauge mentioned, and the springs tightened up if necessary by means of the worm gearing.

In Fig. 6 is shown a special erection expansion joint provided in the main trusses at panel point AM14 over the main pier. During the erection of the bridge the main post over this pier was inclined towards the anchor arm to the extent of about 14 ins. at the top of he post. As the erection of the cantilever arm proceeded the post gradually approached the vertical position and in consequence an adjustable joint had to be provided at the point where the sub-chord on the anchor arm side connected to the main post. This sub-chord after the completion of the bridge, carries both tension and compression stresses, the sub-chord on the cantilever arm side being only a false member and serving no other purpose than to support the sub-vertical post in the first panel of the cantilever arm. The connection of this false member to the main post is by a pin in a slotted hole, so that no axial stress can be taken. Any component force from the sub-tension diagonals on the cantilever and anchor arm sides of the main post is taken by the sub-chord member of the anchor arm. If this slotted connection had not been provided the stresses in the diamond over the main pier would have been statically indeterminate. The necessary adjustments during erection for this sub-chord member were accomplished by means of a forged screw and shackle nuts, pin-connected to the sub-chord and to the main post. After the erection of the bridge was completed the member was adjusted to its proper length and the position maintained by means of the lock nuts provided.

Main rail expansion joints are furnished for the railway tracks at the panel points AF1 and CF1 of the anchor and cantilever arms. The method adopted to provide a continuous track and at the same time take care of the necessary motion from expansion and contraction, is shown in the assembly diagram (Fig. 8) for one of these expansion joints. The device is simple and effective and consists of a manganese casting, FC1L, connecting to the rail on one side of the expansion opening, and tapering to a switch point at the other end of the casting. A rail, FR1L, bent to a curve of 307 ft. radius, leads from the track rail on the other side of the expansion opening and slides against the side of the manganese casting opposite the running edge or track gauge line, the casting having the same curve on this side as the bent rail, which is held firmly against it by the cast steel lugs, FC4. When motion takes place the bent rail slides between the cast steel lugs and the manganese casting in such a manner that the offset between the track gauge line and the bent steel rail is never more than 5/16 of an inch, and this only only at the point where the bent rail meets the tapered end of the manganese casting. The cast-steel lugs, FC2 and FC3, serve as guides for the bent rail and clamp it in position. The whole joint is mounted on a steel plate firmly bolted to the ties and track stringers. The joints for a pair of rails are rights and lefts and are held firmly to track gauge by angle ties connecting the pair of mounting plates of each joint together.

In regard to the amount of adjustment provided at the main expansion joints to take care of errors in location of the main shoe and in the overall manufactured length of the trusses, the final triangulations showed the distance centre to centre of main shoes to be 1,800 ft. 3 ins., which is greater by 3 ins. than the span originally assumed. This error was in the location of the main shoes on the main piers, the overall manufactured length of the trusses being practically as calculated. On the north anchor pier the wind anchorage was 9/16 in. out of position longitudinally, but on the south anchor pier there was no error in the placing of this anchorage and the distance from the centre of the main pier to the centre of the wind anchorage connection was as calculated.

The superstructure of the Quebec Bridge as built was designed, detailed, manufactured and erected by the St. Lawrence Bridge Company, of which Phelps Johnson is president, Geo. Herrick Duggan, chief engineer, and Geo. F. Porter, engineer of construction.

The design and construction of the bridge was checked, supervised and approved in all its details by the Board of Engineers, appointed by the Dominion Government, composed of Lieut.-Col. C. N. Monsarrat (chairman and chief engineer), Ralph Modjeski, and H. P. Borden.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS REPORT OF ANNUAL MEETING

(Continued from last week's issue.)

K. H. Smith, of Halifax, called the attention of the meeting to the status of the society in the Maritime Provinces. He said that it was a matter of great regret that there was no engineering organization in Halifax which could assume any responsible work at the time of the big accident. There should be a branch of the Canadian Society of Civil Engineers in Halifax. They have a well-equipped technical school there, the Nova Scotia Technical College, but the people are in closer touch with New England than they are with "Canada," as many of them call Quebec and Ontario and the West, peculiarly overlooking the fact that Canada includes the maritime provinces. The national Canadian spirit needs fostering in the maritime provinces, said Mr. Smith. Or, putting it another way, all Canada should benefit from the good feeling now existing between the maritime provinces and New England.

There is a lack of interest in the Canadian Society of Civil Engineers all throughout the maritime provinces, claimed Mr. Smith, even among the society's oldest members. In fact, among some of them there is even real antipathy toward the society, due to past friction, no doubt. This resulted ten or twelve years ago in the formation of the Nova Scotia Society of Engineers. This local institution is not now in a flourishing condition, which makes it timely for the establishment of a Halifax branch of the Canadian Society. There are two ways of doing this: First, independently of the local society; second, amalgamating with the Nova Scotia Society and working with them instead of against them. He would suggest that the president and secretary visit Nova Scotia and discuss the matter with the engineers there.

Sir John Kennedy asked what the trouble is that the Nova Scotia engineers are unfriendly to the society. In what way have they been neglected? Mr. Smith said he didn't know why, but the facts exist. There is a general lack of interest. He knew of two Halifax engineers who had resigned from the society and recently another member had expressed his intention of doing so.

Mr. Holgate enquired whether the trouble is not entirely geographical. The maritime provinces are not interested commercially or otherwise in Western Canada to any great extent.

Mr. Ross said that the maritime provinces are isolated to a great degree. If the other society can be amalgamated with the Canadian Society, it should be done as we need the strength, he said.

Mr. Fairbairn thanked Mr. Smith for his information and said that council would look into the matter without delay.

Is the Beaver an Engineer?

Walter J. Francis submitted a pencil sketch of an emblem of the Institute because the beaver is Canadian, he suggested as the official emblem of the Institute. The sketch was passed around and aroused a great variety of opinion. It was circular, with the words "The Engineering Institute" at the top, and "of Canada" at the bottom. In the centre, a large beaver gnawed at a branch of a small maple tree.

Mr. Francis said that he suggested the beaver as the emblem of the Institute, because the beaver is Canadian, the beaver is an engineer, and the beaver is a worker, and if there is any worker in Canada to-day it is the Canadian engineer.

R. A. Ross: "Do you mean the paper?"

Mr. Francis: "I was not referring to *The Canadian Engineer*, Mr. President, but to Canadian engineers as workers, but for that matter I see no reason for not also including the paper in that category."

Mr. Safford expressed his appreciation of the sketch, and said that its donor is one of the greatest beavers in the society. He suggested that the matter be given careful attention by a committee.

Sir John Kennedy questioned whether the society should adopt the beaver as its emblem. He said there are two sides to the beaver's activity. The beaver is not particularly edible, its fur is not very valuable, and it is often a nuisance, cutting down trees and interfering with our waterways. It is not an example of useful industry. It is a great worker but not in useful ways. Leave the beaver off, advised Sir John.

Mr. Vaughan: "No doubt Mr. Safford had many of your ideas in mind, Sir John, when he suggested the reference of the matter to a committee."

Henry Holgate suggested the advisability of putting "1887," the date of establishment of the Canadian Society of Civil Engineers, on the badge, so that the public would not think that the Institute is a new organization.

Prof. Haultain: "How many members have ever seen a beaver cutting down the branch of a maple tree? Is the artist who drew this a nature fakir, or is the badge scientifically correct? Shouldn't that be looked into?"

Says American Badge is Popular

Mr. Francis urged the careful selection of a fitting badge. He claimed that the members of the American Society of Civil Engineers almost always wear that society's badge simply because they think it is a pretty badge and they like it. Mr. Francis offered to wager that every member of the American Society who was in the room, with the single exception of himself, was wearing that society's badge.

The meeting decided to refer the matter to a committee for report on a suitable emblem.

F. A. Dallyn, engineer of the provincial board of health of Ontario, offered the use of the board's experimental plant to the society for carrying out experiments in sewage disposal and water purification. The laboratory had been started in 1909, said Mr. Dallyn, and the province had spent $55,000 on it. American engineers recognize it as being one of the best on the continent. The use of the laboratory was recently offered to the University of Toronto in a similar manner, and the Ontario Cabinet now offered it to the society.

"You have a committee on sanitation," said Mr. Dallyn, "which, if you will pardon me, has performed very little useful work. I would suggest that your committee make use of our laboratory. This offer is subject to one condition, namely, that the provincial board shall have the privilege of publishing any portion of any work done or results obtained by the society's members who conduct the experiments.

"We have an appropriation of $10,000 a year, which covers maintenance. Breakages could be covered by a lab fee, as in the universities. Many members have times when they or their assistants could spend a few weeks or months in this laboratory, determining some special problem or getting in touch with what sanitation specialists are doing.

"At the start of the work of this laboratory, Ontario depended on specialized knowledge from the United States, particularly in water and sewage problems. In the course of seven or eight years, we have largely offset

(Concluded on page 124)

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Principal Contents of this Issue

TRADE AFTER THE WAR

With comparatively little publicity, the United Kingdom is organizing a commercial intelligence system which eventually will prove of great value to manufacturers and traders there and to British Empire trade generally. Sir Albert Stanley, president of the Board of Trade, recently outlined the programme of the Board's extended activities toward increasing overseas commerce, including the dissemination of up-to-date information from all parts of the world. According to cable despatches, a new Department of Overseas Trade will control the Board of Trade's trade commissioner service within the Empire. It is intended to extend the trade commissioner service to India and some of the principal Crown colonies, and to greatly increase its commercial services.

Sir Albert Stanley described a new step in the distribution of information under the pledge of secrecy to traders and manufacturers regarding possible exporters in certain foreign countries of British manufactured goods. The idea is the outcome of the Trading-with-the-Enemy Act. Ten thousand traders have already availed themselves of its use. All whose bona fides are doubtful are checked, with the assistance of leading commercial organizations. Even more secret is the confidential register which provides for wider information regarding trade openings abroad, reports on foreign competitors, and various overseas industries.

Sir Arthur Steel-Maitland, M.P., who will represent in parliament the new Department of Overseas Trade (Development and Intelligence), speaking in London recently stated that it was now plain that before the war we were face to face with a commercial strategy on the part of the enemy just as real as the military strategy they are now employing to-day. "In many foreign countries," he said, "there is a perfect system of penetration by German finance and German industry, and the two are linked together in a way, if we do not wish literally to copy it—for no foreign country is anxious to rid itself of German penetration merely to substitute English—we intend to combat."

In the United Kingdom, in Canada, and in other parts of the Empire, trade intelligence organizations are being perfected. They will become a formidable opponent of enemy trade and will help to increase materially the sales of our Empire's merchandise throughout the world's markets. In this Dominion, some progress has been made in the gathering of information to help meet the competition which will develop for business after the war. There is a Senate Committee, headed by Hon. Frederic Nicholls, which is considering the problems of conservation of Canadian trade. We have also at work committees of industrial and chemical research. Many private corporations, too, are preparing to cope with the questions which will arise in their respective spheres so soon as peace comes.

ORGANIZATION FOR WAR

Referring to the subject of taxation by the Dominion government, Sir Herbert Holt, president of the Royal Bank of Canada, at the annual meeting of that institution last week, stated that while he approved the principle of the income tax, he thought the business profits tax was unduly onerous and repressive, and that it had had the effect of antagonizing capital and restricting production.

This is a point which should have the serious consideration of the government. We must recognize that very large sums of money must be raised by special taxation to carry on our share of the war, but this should be done in a way that will not discourage the investment of capital in existing and new enterprises, increasing production in certain directions necessary for the prosecution of the war. A reasonable proportion of excess profits, having in view the exceptional conditions of war, should be taken but at the same time the efforts of capital and labor should be encouraged by the fairest possible legislation.

Sir Herbert Holt, commenting further on the government's action in such matters, said: "While we believe the government's assumption of the powers mentioned is essential to the prosecution of the war, and are in duty bound to give our full support, the extent to which the domestic life and liberties of the people are thus affected is a serious matter. Dictatorial powers once assumed are usually reluctantly relinquished, and if we could not trust the government to annul them when the present purpose has been served, great evil would result..

This point is well made, but as the war proceeds we believe it will be found that only by thorough organization and the free exercise of State regulation in all the Allied countries, will a definite and favorable decision be obtained in the war area. The course of the struggle during the past 3½ years has shown the necessity for assumption of powers by the State which, in times of peace, might be objectionable. State regulation, nation-wide organization, co-operation with capital and labor, and the obtention for national service, of the best business and financial brains, are four of the factors necessary to finish the war quickly and successfully. The vast war machine must be backed by businesslike organization, in which governments and business men should be partners in harmony. During the present year, this tendency is likely to be sharply defined, and if the war runs into future years, the same tendency will be the dominating factor.

PERSONALS

Lieut.-Col. McPhail, of the Forestry Division, has been recalled from France to act as chief engineer of the Canadian Division in England.

Gordon Grant, M.Can.Soc.C.E., who has been chief engineer of the National Transcontinental Railway, has been appointed expert adviser to the Minister of Railways of the Federal Government, Ottawa.

J. H. Craig, B.A.Sc., of Toronto, who graduated from the University of Toronto, S.P.S., with the class of 1910, has been promoted at the Front to the rank of major. He went overseas as captain and adjutant of the 12th York Rangers.

Lieut.-Col. H. F. H. Hertzberg, D.S.O., M.C., son of A. L. H. Hertzberg, engineer for the C.P.R., Toronto, is one of three brothers on active service. He is an associate member of the Canadian Society of Civil Engineers and went over with the 2nd Field Company, Canadian Engineers. His younger brother, Capt. C. S. L. Hertzberg, who also holds the Military Cross, is adjutant at the Spadina Military Hospital, Toronto, after active service with the engineers, and his youngest brother, Lieut. O. P. Hertzberg, with the 5th Battalion, went overseas as private.

OBITUARIES

Flight.-Lieut. Ralph Gordon Hall, of the Royal Flying Corps, was accidentally killed in a flight collision at Birmingham, England. His father is Thomas Hall, of the Hall Engineering Works, Montreal.

Flight-Lieut. Paul H. Raney, B.A.Sc., Student Mem. Can.Soc. C.E., who was for some time inspector for the G.T.P. Railway and later employed on munitions, has been officially reported killed in action. He was the son of W. E. Raney, K.C., Toronto.

T. F. Sinclair, of Vancouver, died in that city on January 30th, aged 68 years. He was a well-known contractor, had built the New Westminster waterworks plant, constructed a section of the C.P.R. through the mountains, and engaged in many other important works.

Marcel Beullac, M.Can.Soc.C.E., engineer of the Dominion Bridge Company, died suddenly at Montreal on January 27th at the age of 46 years. He graduated from Laval in 1897 and had become prominent in his profession. He was ex-president of the Veterans of Land and Sea and fought in the French Army in this war.

E. G. Millidge, M.Can.Soc.C.E., district engineer of public works in Eastern Nova Scotia, died at Antigonish, N.S., on January 24th, 70 years of age. He was at one time division engineer on location and construction for the Prince Edward Island Railway. In 1873 he entered the service of the Canadian Public Works Department and in 1889 was appointed district engineer, which position he held until his death.

One-half of the water now going to waste in the Niagara River would furnish power equal to that capable of development by the use of 40,000,000 tons of coal a year, is the opinion of Senator George F. Thompson, of Niagara. Senator Thompson made a vigorous appeal for the appointment of a commission to attempt to influence Federal authorities to negotiate a new treaty with Great Britain under which additional water could be diverted for power purposes.

ENGINEERS' CLUB OF TORONTO

The annual meeting of the Engineers' Club of Toronto, the election of directors and other business will be held this evening. The term of office of five directors has expired and nominations to fill these vacancies have been made as follows: Messrs. J. R. W. Ambrose, E. L. Cousins, L. V. Rorke, R. A. Baines, E. G. Hewson, W. R. McRae and E. Ward Wright. The first three mentioned are candidates for re-election to the board.

The revenue account of the club for the year 1917 shows income of \$29,851. The net profit was \$202. The assets of the club amount to \$39,236, including \$1,006 organization expenses, \$17,803 real estate on Queen's Park Avenue, \$11,739 equipment and decorations, \$983 supplies and \$7,702 cash and accounts receivable.

There are 554 members, of whom 398 are resident, 130 non-resident, 14 absent, 10 associates, 1 life member and 1 honorary member.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS REPORT OF ANNUAL MEETING

(Continued from page 122)

that and have used our own municipal engineers for solving their own problems and have used the research laboratory for the special problems. This has put the board in the position of a consultant, fortunately or unfortunately, requiring the board to keep an engineering staff, but it is working out all right from the standpoint of the municipalities. It is to their advantage, but whether it is to the advantage of the engineering profession or not may be another question.

"However, I would urge you to take advantage of this offer, and allow your committee or members to co-operate with this research laboratory. If they cannot come to do the work themselves, perhaps they might indicate special problems the solution of which they would deem of advantage."

Prof. Gillespie pointed out that the report of the Toronto branch committee on sanitation had recommended that the society should use the provincial laboratories.

Andrew Macallum enquired whether the laboratory is equipped to make activated sludge experiments. Mr. Dallyn replied that it is. He said that one of the first Imhoff tanks in the province of Ontario was installed in that laboratory, and that the laboratory had ever since kept in touch with all advances in sewage disposal.

Mr. Fairbairn thanked Mr. Dallyn and the Ontario Ministers for their offer and said it would receive attention and consideration by council.

F. B. Brown requested that something be done to improve the acoustics of the society's auditorium. "And the ventilation," added another member. Mr. Keith explained what causes the bothersome echoes in the hall, and said it would cost \$5,000 to fix it. An electrically driven ventilating system had been installed but is never operated because it would cost \$15 a month for standby charges for current, and to save this item the power had been disconnected.

After a vote of thanks to the retiring council and officers of the society, the annual meeting was adjourned about 11.30 a.m. The new council held a meeting at 2 o'clock in the afternoon and organized committees, etc., for the coming twelve months' work.

The new plant of the Port Arthur Pulp & Paper Company, with a capacity of 50 tons of pulp daily, is to commence operations in a few days.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Reconstruction of Queen Street Sewer, Toronto

Wooden Separating Troughs Used for First Time in Toronto Sewers — Details of Diversion Chambers — Quantities and Costs

By W. S. HARVEY* and W. G. CAMERON†

THE existing combined sewer on Queen Street was constructed in 1884, being an egg-shaped sewer, 2 ft. 4 ins. x 3 ft. 6 ins. of 9-in. brickwork and laid at an invert grade of 1 in 933 with a capacity of 15.3 c.f.s., its outlet on Leslie Street being a 3-ft. 6-in. circular brick sewer at a minimum grade of 1 in 500 and a capacity of 38.8 c.f.s.

From inspections made from time to time, it was found that the sewer on Queen Street was in a very dilapidated condition and in danger of collapse. Having for the greater part of its length only 3 ft. 6 ins. of cover, and being located in the centre of the street, the vibrations caused by the street car traffic helped considerably in weakening the crown of the sewer, the bricks of which were working loose and falling in.

This sewer was also too shallow to drain the basements on Queen Street and Leslie Street, and many of the residences on the streets running north from Queen Street have suffered through flooding due to the bad condition of the sewer.

Location

The new sewers, both storm and sanitary, commence near the southern portion of Eastern Avenue and extend northward on Leslie Street as far as Queen Street, thence westerly on the north side of Queen Street to Pape Avenue, the sanitary sewer being connected to the low-level intercepting sewer, and the storm sewer having a temporary connection with the existing brick sewer.

As can be seen from Fig. No. 1. which shows a cross-section of the street, there was very little available space on Queen Street to accommodate the new sewers. After several comparative estimates had been made, it was decided to remove the 6-in. water main and lay both sewers on the line of the old main, the sanitary sewer being directly underneath the storm sewer. One reason for constructing the new sewers on the north side of Queen Street was to obviate crossing the street railway tracks with the double line of sewer from the relief chambers at each street intersection. Fig. No. 2 shows four views of a typical manhole for serving both sewers on Queen Street.

The sanitary sewer on Leslie Street is located west of the centre of the street, while the storm sewer is located under the sidewalk for a distance of 350 feet, the remaining portion being on the east side of the roadway.

In the portion under the sidewalk, the reinforced roof slab is marked in squares to resemble and serve as a standard city walk. This was found necessary owing to lack of cover over the roof slab.

Fig. No. 2.—Details of Manhole

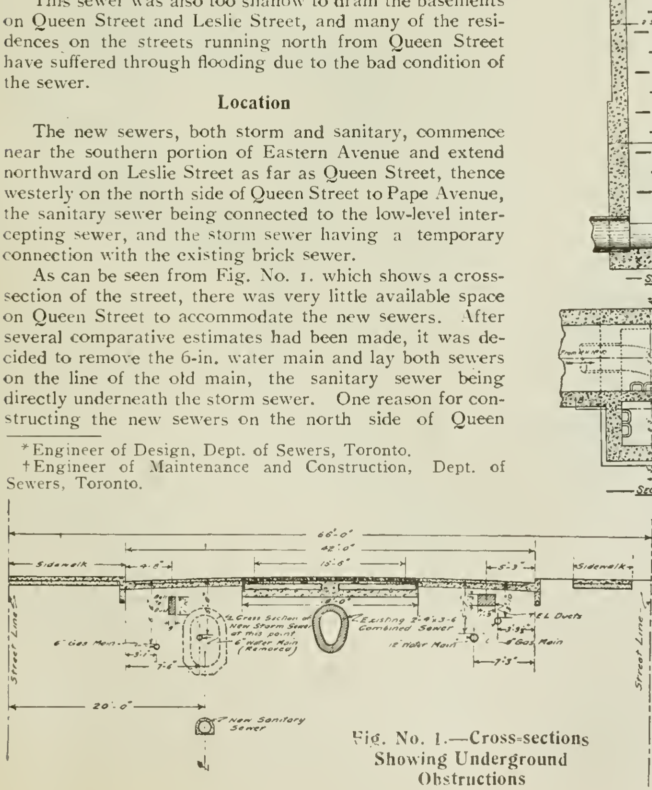

Fig. No. 1.—Cross-sections Showing Underground Obstructions

Requirements

The new sewers were designed with a view to giving better drainage facilities, both sewers being kept at such a depth that all present flooding would be eliminated. In the case of the sanitary sewer, the depth was decided on with due regard

*Engineer of Design, Dept. of Sewers, Toronto.
†Engineer of Maintenance and Construction, Dept. of Sewers, Toronto.

to the likelihood of buildings being erected in the future which may require deep basements.

The existing private drain connections from buildings fronting on Queen Street and Leslie Street were connected to the sanitary sewer, which is thus called upon to take

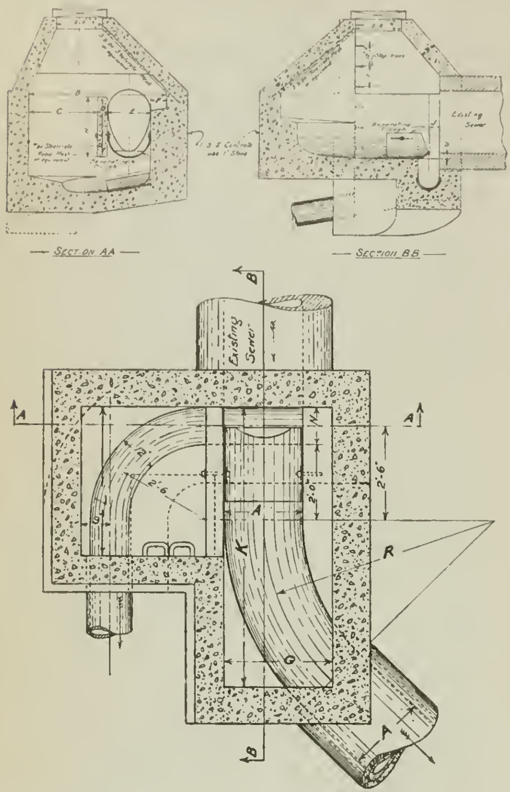

Table of Dimensions for Drawings of Typical Diversion Chamber

Street	A	B	C	D	E	F	G	H	J	K	ZG1/A	R	L	M	N
Brooklyn	2'-0"	6'-6"	3'-3"	6"	2'-0"	9"	2'-9"	2'-6"	4½	7'-6"	0.10	6'-0"	5'-0"	6"	12"
Bertmount	1'-0"	4'-9	2'-9	6"	12"	6"	2'-0"	1'-6"	3"	5'-6"	3.00	3'-0"	4'-0"	3½	12"
Coady	1'-3"	4'-10"	2'-10"	4"	13"	5"	2'-0"	1'-6"	3"	6'-0"	0.50	4'-6"	4'-0"	3½	12"
Jones	2'-0"	6'-6"	3'-3"	6"	2'-0"	9"	2'-9"	3'-0"	7"	7'-6"	0.80	6'-0"	4'-0"	3½	12"
Curzon	1'-3"	4'-10"	2'-10"	4"	15"	5"	2'-0"	2'-0"	4½	6'-0"	2.50	4'-6"	4'-0"	5½	12"
Leslie	1'-3"	4'-10"	2'-10"	4"	15"	5"	2'-0"	2'-0"	12"	4'-0"	1.35	4'-6"	4'-0"	6	15"

Fig. No. 3.—Details of Typical Diversion Chamber

the sanitary sewage, roof water and wash water from basements, but all buildings erected in the future will require to be provided with two connections, one to connect to the storm sewer which will take roof water, and the other to connect to the sanitary sewer which will take sanitary sewage and wash water.

The storm sewer will also take all surface water from gullies on the portion of Queen Street and Leslie Street drained by it.

New Sanitary Sewer

The area drained by the sanitary sewer is approximately 91 acres. All the sewers on the streets running north from Queen Street are combined sewers, thus necessitating separating chambers on each sewer near the north street line of Queen Street.

The separating of the sanitary from the storm flow is effected by special adjustable wooden troughs which are set to allow three times the dry-weather flow pass to the sanitary sewer and thence to the low-level interceptor, this quantity being the basis of design of the latter trunk sewer. The remainder of the storm water passes through the trough and thence to the storm sewer.

Fig. No. 3 shows three views of a typical diversion or separating chamber, together with a table of measurements to apply to the various chambers.

It might be mentioned that wooden separating troughs were used in Toronto for the first time on this sewer, it being the practice in the past to use steel, but, owing to the increased cost of the metal, they have been temporarily abandoned. These wooden troughs are well coated with preservative and should last many years.

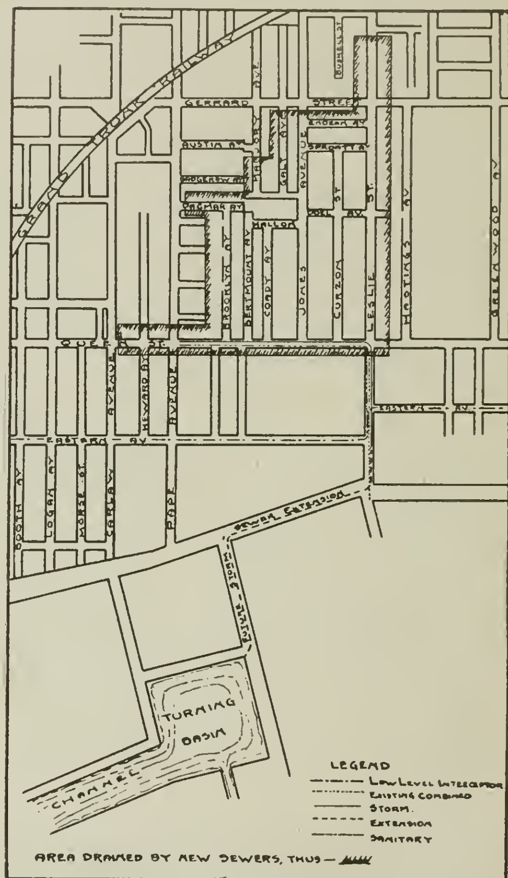

Fig. No. 4.—Reconstruction of Queen Street Sewer

The chart for the sanitary sewer gives all figures of flows, velocities, sizes and grades, etc., in connection with it.

The dry-weather flow from the area drained by the sanitary sewer was calculated in the following manner:

Average number of houses per acre, 8; average number of persons per house, 5, or 40 persons per acre; consump-

tion per capita per diem, 120 gals., or half of this quantity run off in 8 hours gives $7\frac{1}{2}$ gals. per capita per hour, or 300 gals. per acre per hour, or 48 cu. ft. per acre per hour, or .013 cu. ft. per second per acre.

New Storm Sewer

The area drained by the storm sewer is 97 acres, shown in Fig. No. 4. The area drained by the sanitary sewer is identical with the exception of the northern limits.

From actual measurements taken of the roofs, paved and unpaved streets and lanes, boulevards and private lawns in the portion of the city which includes this area, it was found that the average coefficient of impervious area was .35, the rainfall intensity being taken at $1\frac{1}{2}$ inches per hour.

In arriving at the sizes of the different sections of the sewer, no allowance was made due to concentration on account of the rapidity with which the storm water reaches Queen Street, and the necessary flat grades and consequent low velocities in the new storm sewer.

At the present time, the existing 3-ft. 6-in. diameter brick sewer on Leslie Street is used as the outlet for the new sewer with which it connects at a point just south of the south portion of Eastern Avenue. In fixing the hydraulic grade of the sewer, it was borne in mind that

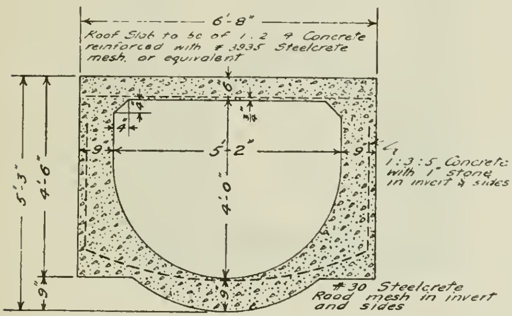

Fig. No. 5.—Cross-section of Storm Sewer Outlet

it would, at some future time, be extended to the new turning basin in the Toronto Harbor Industrial District, the water level at the point of future outlet being taken at 249.00, or maximum lake level.

The limiting elevation to guard against flooding under the worst possible conditions was found to be when the crown of the new sewer was level with the crown of the existing sewer on Jones Avenue at Queen Street. This would cause the existing sewer on Coady Avenue to back up one foot, or to elevation 253.77. As the level of the lowest basement on Coady Avenue is 256.28, there is no fear of flooding when the sewer is flowing under maximum conditions. Fig. No. 4 shows the proposed extension which, when carried out, will give a total length of storm sewer of approximately 6,400 feet.

Construction

The contract for this work was secured by Messrs. Fussell-McReynolds Co., who began the construction work by building the 18-in. sanitary sewer on Leslie Street. Then the storm sewer was proceeded with on Leslie Street, commencing at its outlet at Leslie Street and the southern portion of Eastern Avenue, and thence the remainder in order to its terminus at Queen Street and Pape Avenue. The soil throughout was a light, dry clay loam.

It had been intended to cut the old storm sewer off at the south end of the new sewer and make use of the old outlet, but as there was found to be still considerable flow in the old sewer, and as it was a wet season, it was feared

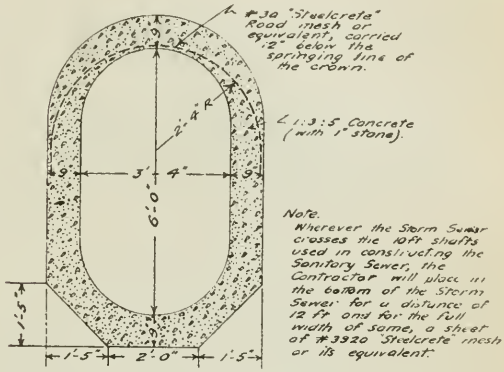

Fig. No. 6.—Typical Cross-section of Storm Sewer on Queen Street

that a heavy storm might occur before the new sewer was ready. A bell-mouth was therefore built at this point and a weir left as high as the springing line of the old sewer (which is a 3-ft. 6-in. circular brick), so that any surplus water might flow over and continue on in its old course.

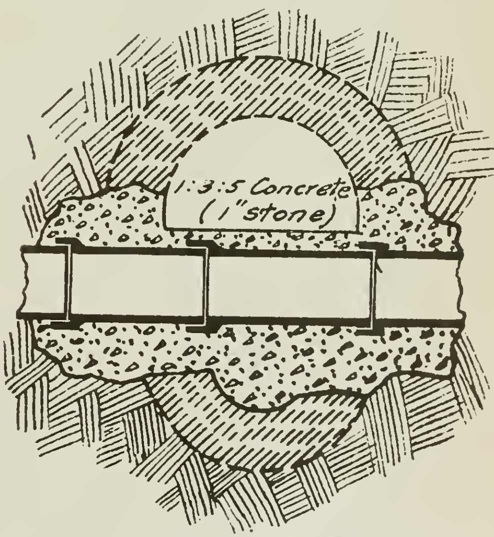

Fig. No. 7.—Cross-section Showing Method of Carrying Private Drains Through Old Sewer

At the outlet, a curve was necessary to bring the sewer over from the east side to the centre of the street, and as it would have been very expensive to build a full set of forms for this small piece of work, brick was used for the walls and invert, but a reinforced concrete slab was used for a roof as in the other portion of the sewer.

The concrete forms for this sewer were made of wood, but great care was given to the lagging used in order that it might be a correct fit. When the forms were ready for use, they were thoroughly cleaned and greased so that a perfectly smooth face would be given and no finishing would be necessary. It had been specified that no finishing would be allowed and that any uneven spots must be smoothed with a carborundum stone. Some difficulty was found in keeping the forms from floating. The concrete was well spaded and worked. To overcome this tendency to floating, the forms were built in two sections, the bottom section being brought up to the top of the curve shown in Fig. No. 5, and the straight portion of the wall forms being attached to the top slab form. The bottom portion of the form was set alone and walings with very tight struts were placed across the top of the form to hold it down. Later, when the sewer traversed a piece of ground which was fill, and the earth in the sides of the cut was, owing to this, rather loose, sheeting had to be left in in order that the walings might have a firmer hold on the bank.

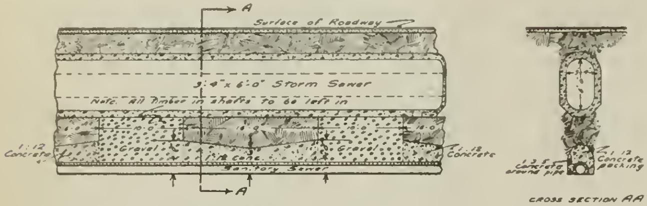

Fig. No. 8.—Showing Method of Construction on Queen Street

From the northern portion of Eastern Avenue to Queen Street, the sewer had sufficient cover and, there being room, was swung out into the street. The new line was along that of an old 4-ft. box storm sewer which had been used before the 3-ft. 6-in. brick sewer was built. This box sewer had to be removed and it was found that, for most of the distance, the sides and top were either on the point of collapsing or had already done so. The bottom, however, owing to its being buried under 1 ft. to 2 ft. of wet muck, was as sound as it was when first built. In crossing Eastern Avenue and swinging out into the street, the sewer had to traverse several old cuts such as those for the low-level interceptor, water main and gas main, and as these were found to be still far from solid, double reinforcing had to be used in the invert.

At Queen Street, it had been intended to carry the sewer through under the tracks to the north side of the street, with the cross-section shown in Fig. No. 5. Owing to the flat crown, it was considered that the local water main would pass over the top. But this part of the main had been relaid when the old brick sewer was built along Queen Street and had been placed at a lower elevation than indicated; therefore, when the excavation was made, it was found that a syphon would have to be placed in the main under the sewer. The necessity for the slab section having been thus removed, the section shown in Fig. No. 6 was carried through to the south side of the street and the bell-mouth placed there. This made the construction much easier, as the cut was narrower and left less track to be supported.

The method followed in building the sanitary sewer on Queen Street was to open-cut 10 ft. and tunnel 16 ft. alternately, as shown in Fig. No. 8. The sanitary sewer being under the storm sewer, the open-cut portions had to be solidly filled with pit gravel which was used for this purpose. It was placed and spread in layers, thoroughly soaked and pounded until it was in a solid mass. As an extra precaution against any possible settling, the bottom of the storm sewer was reinforced over these open cuts with 3:9:20 road-mesh. The sheeting for the open cut of the storm sewer, on account of the nearness of the street railway tracks (3 ft.) had to be placed horizontally instead of vertically. The sheeting in the 16-ft. open cut for the sanitary sewer was placed vertically. It was hardwood, and was left in place after construction.

Owing to the fact that the cut for the sewer along the north side of Queen Street was confined to a narrow strip near the track and that pedestrian traffic had to be maintained on the north sidewalk, a stationary or travelling derrick could not be used, and a Carson trenching machine was made use of to carry all excavated material back, to be used either as backfill or to be carried away in waiting wagons to a nearby dump. With this method used to dispose of the excavated earth, the excavation for the sanitary sewer, with the exception of the mined portions, was made as cheaply as the excavations for the storm

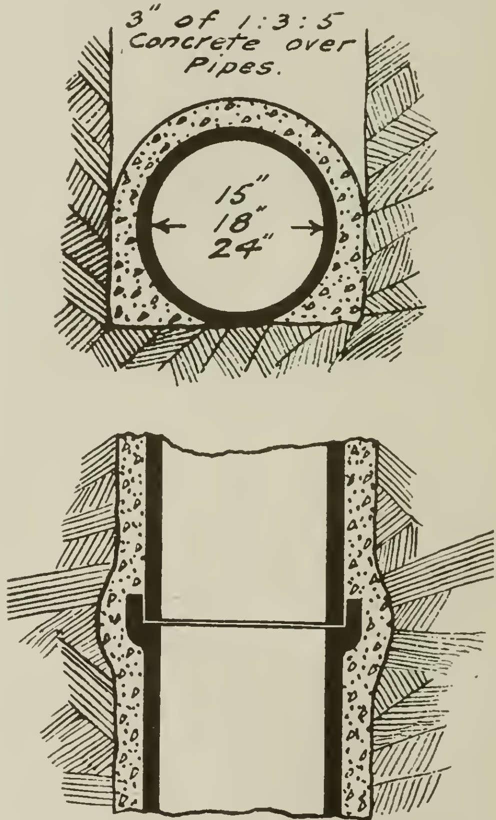

Fig. No. 9.—Sections Showing Method of Laying 15-in., 18-in. and 24-in. Tile Pipe

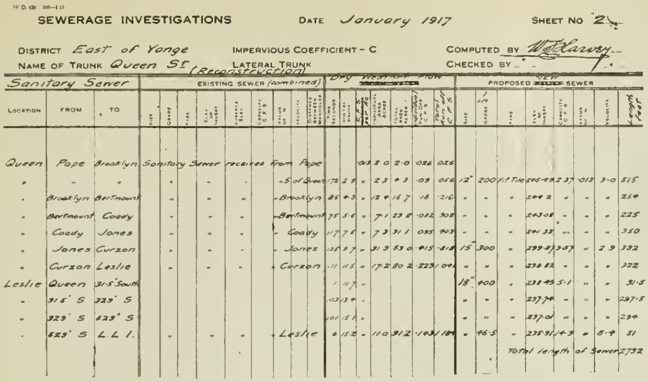

Chart for Sanitary Sewer

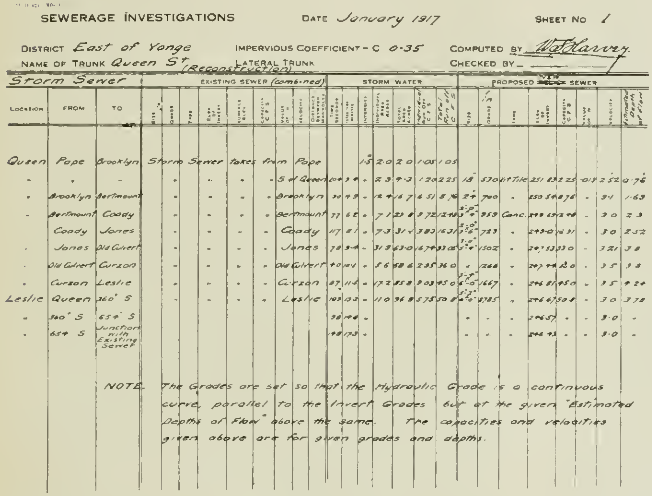

Chart for Storm Sewer

sewer. The mining was done by the pipelayer who, himself, was an expert at either job, but at the time was only receiving pipelayer's wages. So, we might say that the excavation for this sanitary sewer was made as cheaply as that for any pipe sewer in ordinary open cut. The space in the tunnel not occupied by the sanitary sewer was packed with concrete. This packing was 12 to 1 mix with 1-in. stone, and had to be carefully done owing to the fact that the storm sewer was built overhead. The following was the method used:—

A bulkhead was placed in one end of the tunnel over the sewer and an 8-in. hole was bored through the roof of the tunnel near each end. Concrete was then poured through the hole nearest the bulkhead until that end of the tunnel was filled, a man being placed to pack in the concrete with a long pole. The pouring was continued here until the concrete flowed out at the other end of the tunnel when another bulkhead was placed in it and the remainder of the packing poured through the adjacent hole.

When the first intersecting street (Curzon Street) was reached by the excavation, it was found that the bottom corner of the manholes for the Bell Telephone conduit would project into the arch of the sewer.

(Concluded on page 130)

Costs of Sewer on Queen Street Between Leslie Street and Pape Avenue

The work includes 2,122 lin. ft. of storm sewer and 2,051 lin. ft. of tile pipe sanitary sewer. The bricklayer's time was occupied entirely in the building of twenty manholes, twelve of which included the building of diversion or separating chambers.

Quantities

Excavation for storm sewer ..	2,359 cu. yds.
Excavation for sanitary sewer	1,770 cu. yds.
Pit gravel (backfill in shafts).	1,356 cu. yds.
1 : 2 concrete for packing	180 cu. yds.
Backfill for storm sewer	817 cu. yds.
Surplus from storm sewer ...	1,442 cu. yds.
Surplus from sanitary sewer..	1,770 cu. yds.
18-in. tile pipe storm sewer ..	515 lin. ft.
24-in. tile pipe storm sewer ..	280 lin. ft.
2′ 0″ x 3′ 4″ concrete storm sewer	215 lin. ft.
2′ 0″ x 3′ 4″ concrete storm sewer	340 lin. ft.
3′ 0″ x 5′ 4″ concrete storm sewer	380 lin. ft.
3′ 4″ x 6′ 0″ concrete storm sewer	283 lin. ft.
12-in. tile pipe sanitary sewer	1,344 lin. ft.
15-in. tile pipe sanitary sewer	707 lin. ft.
Concrete for storm sewer ...	530 cu. yds.
Concrete for sanitary sewer ..	28 cu. yds.
3-9-20 "Steelcrete" mesh ...	5,544 sq. ft.
No. 30 road mesh	5,194 sq. ft.

Item.	Charge.	Labor.	Unit cost.
Foreman	2,122 lin. ft.	382 days	0.18 days per lin. ft.
Engineer	2,082 lin. ft.	1,095 hrs.	0.53 hrs. per lin. ft.
Signalman	2,082 lin. ft.	1,055 hrs.	0.51 hrs. per lin. ft.
Timekeeper	2,122 lin. ft.	1,280 hrs.	0.60 hrs. per lin. ft.
Teams	2,122 lin. ft.	2,155 hrs.	1.02 hrs. per lin. ft.
Team foreman	2,122 lin. ft.	1,400 hrs.	0.66 hrs. per lin. ft.
Cement	2,122 lin. ft.	6,331 bags	2.98 bags per lin. ft.
Bricks	20 manholes	49,900 bricks	2,490 bricks per M.H.
Labor in excavation..	2,359 cu. yds.	8,075 hrs.	3.42 hrs. per cu. yd.
Labor in sheeting ...	8,244 lin. ft., trench	1,011 hrs.	0.12 hrs. per lin. ft.
Labor in backfill	817 + 1,356 cu. yds.	1,590 hrs.	0.73 hrs. per cu. yd.
Labor in surplus	3,212 cu. yds.	528 hrs.	0.16 hrs. per cu. yd.
Handling material ..	2,122 lin. ft.	843 hrs.	0.40 hrs. per lin. ft.
Pipelaying	2,846 lin. ft.	1,734 hrs.	0.61 hrs. per lin. ft.
Watchman	2,122 lin. ft.	1,680 hrs.	0.80 hrs. per lin. ft.
Carpenter (forms) ..	481 cu. yds. concrete	1,300 hrs.	2.70 hrs. per cu. yd.
Carpenter's helper ..	481 cu. yds. concrete	1,784 hrs.	3.71 hrs. per cu. yd.
Labor on concrete ...	530 cu. yds.	3,650 hrs.	6.90 hrs. per cu. yd.
Bricklayer	49,900 bricks	521 hrs.	10.44 hrs. per M.
Bricklayer's helper ..	49,900 bricks	1,194 hrs.	23.88 hrs. per M.
Rehandling material.	2,122 lin. ft.	1,342 hrs.	0.63 hrs. per lin. ft.

Costs of Storm Sewer on Leslie Street

Size of sewer, 5′ 2″ x 4′ 0″.

Quantities

Brick sewer (8,895 bricks) at junction with old sewer	32 lin. ft.
Concrete sewer with slab top	1,044 lin. ft.
Excavation	2,084 cu. yds.
Backfill	427 cu. yds.
Surplus	1,657 cu. yds.
1:2:4 concrete for slab	130 cu. yds.
1:3:5 concrete in walls and invert	348 cu. yds.
3-9-35 "Steelcrete" mesh	5,760 sq. ft.
No. 30 road mesh	11,328 sq. ft.
3-6-60 "Steelcrete" mesh	530 sq. ft.

Item.	Charge.	Labor.	Unit cost.
Foreman	1,044 lin. ft. of sewer	75 days	0.07 days per lin. ft.
Engineer	1,044 lin. ft. of sewer	40 hrs.	0.04 hrs. per lin. ft.
Timekeeper	1,044 lin. ft. of sewer	370 hrs.	0.35 hrs. per lin. ft.
Teams	1,044 lin. ft. of sewer	984 hrs.	0.94 hrs. per lin. ft.
Foreman teamster	1,044 lin. ft. of sewer	45 days	0.04 days per lin. ft.
Labor in excavation	2,084 cu. yds.	3,072 hrs.	1.47 hrs. per cu. yd.
Labor in backfill	427 cu. yds.	115 hrs.	0.27 hrs. per cu. yd.
Labor in sheeting	2,152 lin. ft.	146 hrs.	0.07 hrs. per lin. ft.
Labor in surplus	1,657 cu. yds.	660 hrs.	0.04 hrs. per cu. yd.
Carpenter (forms)	1,044 lin. ft.	980 hrs.	0.94 hrs. per lin. ft.
Carpenter's helper	1,044 lin. ft.	1,083 hrs.	1.04 hrs. per lin. ft.
Labor in concrete	478 cu. yds.	1,756 hrs.	3.67 hrs. per cu. yd.
Bricklayer	8,895 bricks	49 hrs.	5.50 hrs. per M.
Bricklayer's helper	8,895 bricks	50 hrs.	5.62 hrs. per M.
Labor in finishing	2,333 sq. ft.	131 hrs.	0.06 hrs. per sq. ft.
Finisher's helper	2,333 sq. ft.	126 hrs.	0.05 hrs. per sq. ft.
Watchman	1,044 lin. ft. of sewer	638 hrs.	0.61 hrs. per lin. ft.
Labor on pumps	1,044 lin. ft. of sewer	218 hrs.	0.21 hrs. per lin. ft.
Cement	3,216 bags.		

Note.—Backfill was done mostly with team and scraper. Very little sheeting was required owing to the shallow trench. The bricklayer and helper also did the work of finishing the slab for sidewalk. Pumps had to be used at junction with old sewer.

Costs of Sanitary Sewer on Leslie Street

Quantities

18-in. tile pipe, 16 ft. 4 ins. deep, 3 ft. 6 ins. wide	674 lin. ft.
Excavation	1,427 cu. yds.
Surplus	150 cu. yds.
Concrete	75 cu. yds.
Lumber	1,000 ft. B.M.
Trench to be sheeted	1,348 lin. ft.
Manholes	4
Brickwork (196 bricks to lin. ft.)	68 lin. ft.

Item.	Charge.	Labor.	Unit cost.
Foreman	674 lin. ft. of sewer	686 hrs.	1.02 hrs. per lin. ft.
Engineer	674 lin. ft. of sewer	55 hrs.	0.08 hrs. per lin. ft.
Carpenter (forms)	674 lin. ft. of sewer	280 hrs.	0.41 hrs. per lin. ft.
Teams	674 lin. ft. of sewer	628 hrs.	0.93 hrs. per lin. ft.
Timekeeper	674 lin. ft. of sewer	100 hrs.	0.15 hrs. per lin. ft.
Bricklayer	13,300 bricks	102 hrs.	7.67 hrs. per M.
Bricklayer's helper	13,300 bricks	231 hrs.	17.37 hrs. per M.
Labor on pumps	674 lin. ft. of sewer	60 hrs.	0.09 hrs. per lin. ft.
Labor on material	674 lin. ft. of sewer	275 hrs.	0.40 hrs. per lin. ft.
Labor on excavation	1,427 cu. yds.	3,128 hrs.	2.19 hrs. per cu. yd.
Labor on backfill	1,277 cu. yds.	535 hrs.	0.42 hrs. per cu. yd.
Labor on sheeting	1,348 lin. ft.	803 hrs.	0.60 hrs. per lin. ft.
Watchman	674 lin. ft.	540 hrs.	0.80 hrs. per lin. ft.
Pipelayer	674 lin. ft.	168 hrs.	0.25 hrs. per lin. ft.
Pipelayer's helper	674 lin. ft.	153 hrs.	0.23 hrs. per lin. ft.
Labor on concrete	674 lin. ft.	597 hrs.	0.88 hrs. per lin. ft.
Labor on concrete	75 cu. yds.	597 hrs.	7.96 hrs. per cu. yd.
Cement	613 bags.		

Cost of Making Connections on Leslie Street

Foreman	8 connections	60 hrs.
Labor	8 connections	567 hrs.
6-in. pipe	186 lin. ft.	
6-in. bends, No.	21	
Cement	11 bags	

(Continued from page 129)

After the consent of the Bell Telephone Co. was obtained, the projecting corners of the manholes were chopped out and the concrete arch of the sewer formed the new bottom of the manhole. There were four of these manholes and the cutting-out process proved a rather hard piece of work, for not only was the concrete a foot thick, but it was of the very best material and workmanship. The labor involved in removing about 10 square feet was 15 hours.

Just west of Curzon Street, an old stone and brick culvert had to be crossed and it was found, when it was reached, that the ground on either side (which had been the bed of an old creek) had been the burying ground in its day of all the nearby undesirable logs and stumps. These, owing to the boggy nature of the surrounding ground, were as sound as ever and had to be sawed and chopped until removed. The old culvert here had a flat roof and the roof-slab had been reinforced with solid steel plates 1 in. thick. When all the muck, etc., was removed from the bottom of the culvert, it was found that the underside of the new sewer would come 1 ft. above it, and this space was filled with 1:4:9 concrete. A 15-inch tile pipe was then built into the sewer and to the upper end of the culvert, the ends of which were then bulkheaded so that all the water which follows this old watercourse now flows into the storm sewer.

At Pape Avenue, a connection was made to pick up the old Queen Street sewer and here the road under the pavement was found to be built up by successive layers of corduroy. Some of the logs were two feet in diameter and, although worn by traffic, were still quite sound, and chopping them out proved a tedious piece of work.

The old private drains on Leslie Street were disconnected and carried across under the storm sewer to the new sanitary sewer, while on Queen Street they were connected directly to the sanitary sewer. In order to accomplish this, however, the drains had to be carried in the manner shown in Fig. No. 7, across the old sanitary sewer in the centre of the street to which they were formerly connected. All these connections were made after the completion of the sewer, but with a view to economy the connections were brought up to the level of the storm sewer at the time of its construction.

The sewer as a whole is a fine piece of workmanship and is a credit to the contractors, Messrs. Fussell-McReynolds, and the resident engineer for the city, Mr. R. T. G. Jack. All the concrete was mixed with a Wettlaufer mixer which was driven by a gas engine. Contrary to the usual custom in Toronto, the fuel used was not gasoline but ordinary coal oil, about 1 gallon of which was sufficient for the day's run of about 10 cu. yds., or roughly, a cost of 2 cts. per cubic yard for fuel.

THE LOGICAL PROPORTIONING OF CONCRETE AGGREGATE*

By Joel D. Justin, Mem.Am.Soc.C.E.

SPECIFICATIONS governing concrete construction generally require that 1 : 2 : 4 concrete be used in the best class of reinforced concrete construction. In other reinforced concrete work and in some mass concrete work 1 : 3 : 5 concrete is specified, while in other mass work such as dams, gravity retaining walls, etc., 1 : 3 : 6 concrete is generally required.

Although this manner of specifying various classes of concrete is general, it is illogical, frequently leading to unnecessary expense on work of magnitude, and is occasionally dangerous, in that it sometimes leads to the erection of structures, which, instead of having the factor of safety assumed by the designer, have instead, a much smaller factor of safety.

Of course it is the purpose of all proportioning of concrete materials to secure a concrete which is sufficiently strong and dense for the purpose in hand. Thus it is usually assumed by the writer of specifications that 1 : 2 : 4 concrete will give an ultimate strength of 2,000 pounds at an age of 28 days. As a matter of fact, the concrete actually used in the work may have an ultimate compressive strength at an age of 28 days of either 1,300 pounds or 4,000 pounds per square inch. In the first instance, the actual factor of safety in the structure is much less than that assumed by the designer and the structure may be unsafe. In the latter instance, the factor of safety is twice that assumed by the designer, and in the case of reinforced concrete, this additional strength does not really give an additional factor of safety to the structure, for the reason that the steel is proportioned on the basis of 2,000 pounds ultimate compressive strength in the concrete. In this latter case a considerable sum might have been saved by using a weaker mix in the concrete, giving an ultimate strength of about 2,000 pounds and this without falling below the factor of safety in the structure used by the designer. In the first case a richer mixture should have been used in order to obtain a concrete having an ultimate strength of 2,000 pounds.

For these reasons it would be better to entirely do away with the arbitrary specifying of proportions in concrete and substitute in the specifications, clauses similar to the following:

Class "A" Concrete.—All concrete in the deck of the hollow dam, all beams, girders and floors, and all other concrete designated on the plans as Class "A", shall be accurately proportioned in accordance with the directions of the engineer, to secure as nearly as possible, a concrete of an ultimate compressive strength of 2,000 pounds per square inch at an age of 28 days; but all concrete of this class shall contain at least enough cement to fill the voids in the sand with an excess of 10 per cent., and enough mortar to fill the voids in the crushed stone or gravel with an excess of 10 per cent.

*Abstracted from article in The Cornell Civil Engineer.

Class "B" Concrete.—All concrete in the buttresses of the hollow dam, in the foundations of the power house, in the concrete spillway and in other structures designated on the plans as Class "B" concrete, shall be accurately proportioned in accordance with the directions of the engineer, to secure as nearly as possible, a concrete of an ultimate compressive strength of 1,400 pounds per square inch at an age of 28 days; but all concrete of this class shall have at least enough cement to fill the voids in the sand with an excess of 5 per cent. and at least enough mortar to fill the voids in the crushed stone or gravel with an excess of 10 per cent.

The ultimate compressive strength at an age of 28 days is to be obtained by testing to destruction 8-in. x 16-in. concrete cylinders in accordance with the methods recommended in the report of the Joint Committee on Concrete and Reinforced Concrete. If it is necessary to use small cubes for test specimens, the proper corrections should be made based on comparative tests with standard test cylinders. For instance, six-inch cubes give results from 20 to 25 per cent. greater than standard test cylinders.

For the purpose herein outlined, it is essential that the test cylinders should be filled with concrete from the mixers as operated on the job, instead of being made up in the laboratory, as outlined in the report of the Joint Committee. This is most important as the object of these tests is to obtain as nearly as possible, a measure of the actual compressive strength of the concrete in the structures. Conditions on a construction job are never ideal, and the compressive strength of the concrete will sometimes be less than the strength of the same concrete mixed in the laboratory in accordance with the standard laboratory practice. In filling the cylinder moulds from the mixer or bucket, the concrete should be puddled with a stick so as to completely fill the mould. Directions for filling the moulds should be included in the specifications.

If such clauses as those outlined above are included in the specifications on contract work, it is necessary to have a separate price for cement or else to have the owner furnish it. This practice is already becoming quite general on large undertakings and has manifest advantages.

On all plans it should be clearly stated what class of concrete is to be used in each and every structure, and the designer should adhere to the ultimate compressive strength stated in the specifications, using to obtain his safe working stresses, the percentages recommended by the Joint Committee on Concrete and Reinforced Concrete in their final report, published in the "Proceedings of the American Society of Civil Engineers" for December, 1916.

With plans and specifications arranged as outlined above, it becomes the duty of the engineer on the job to secure the desired strength in the concrete without unnecessary expenditures for cement. On very small jobs extensive tests would of course not be justified, but some should be made and the engineer should be careful to use more than enough cement to give the desired strength. As the size of the job increases, the amount which should properly be spent on such work as this, rapidly increases.

The matter should be considered from an economic standpoint. On work involving 30,000 yards of concrete there are generally used, about 42,000 barrels of cement. If by the introduction of logical methods of proportioning $5,000 worth of cement could be saved, the slight expenditure for the tests would certainly be well justified. Besides this there is the assurance that the factors of safety assumed by the designer are much more nearly attained.

Before contracts are let and before the erection of the construction plant has been started, the vicinity of the site should be most thoroughly prospected for concrete materials by means of numerous test pits. The samples from the pits may be tested in a field laboratory or sent to a commercial testing laboratory. A mistake frequently made is to base deductions relative to a sand or gravel pit on samples taken from very shallow test pits. The depth to which the deposit is to be worked should be anticipated and samples taken at 2-foot intervals down to that depth in the test pits.

Possible quarries in the vicinity should be investigated and samples of the stone tested to determine its usefulness as concrete aggregate. The product of commercial quarries, sand banks and gravel pits in the vicinity within freighting distance should be investigated. In fact, no possible source of concrete aggregate should be neglected. In order to arrive at the proper decision for work of magnitude, several hundred individual tests may be required.

Such preliminary investigations should precede the final design of the structures. The presence of a suitable quarry in the vicinity may be the determining factor in the adoption of a gravity cyclopean masonry dam, instead of a reinforced concrete dam of arched or buttressed type. It may be found that it will pay to use a gravel from a greater distance owing to the fact that such gravel may give a better grading than the gravel near at hand.

Even where fair gravel is located near the site, it may sometimes pay to crush stone in order to obtain a better grading of aggregate and hence a greater strength. There are very few banks of gravel so well graded from the finer sand particles to the coarser gravel, that it would pay to use the run of bank without separating the sand from the gravel. Generally there is a large excess of sand, and when there is not, the grading is apt to vary greatly in different parts of the pit. On work of magnitude it will nearly always pay to put in a screening plant to separate the sand from the gravel and frequently a crusher to reduce the oversize. It will generally be more economical to crush the oversize stones than to reject them. This practice has the additional advantage, that in breaking up the oversize, a certain proportion of fines are made. These screenings from the crusher, when added to the sand, will frequently produce a much better grading than that of the sand alone. The maximum size of the coarse aggregate should be determined in accordance with the purpose to which the concrete is to be put. If it is to be used in thin reinforced concrete walls, for instance, the maximum size should be one inch while if we are dealing with massive structures, a maximum size of three inches for the coarse aggregate is not objectionable.

If there is any question about the water which is proposed to be used in the concrete, it should be analyzed to determine its suitability. Sometimes effluent, discharged from chemical plants or from pulp mills, becomes so diluted at ordinary river stages that the effect on the suitability of the water is nil. The same stream, however, at minimum river stages may become dangerously unsuitable for concreting purposes. Water containing much sewage should never be used for concrete except after a most thorough investigation to determine its effect. The suitability of the water supply should be determined in advance of construction and thereafter should require but little attention.

In well-stripped pits operated by steam shovel or drag line with a face of 20 feet or more, there will generally be no danger of getting an injurious percentage of vegetable matter owing to the fact that the upper strata, which contains the vegetable matter, will become, by the operation of the shovel or drag line, well mixed with the strata lower down in the pit.

The presence of clay or silt in sand is not necessarily injurious up to a maximum of about 10 per cent., provided the particles of sand are not coated. If the sand is coated, the strength of the mortar may be seriously affected. Commercial washing of sand so coated may improve it but this can not always be relied upon. The presence of the coating may be determined in the following manner: Wash the sample thoroughly with water; then place some of the washed sample in a bottle with a 5 per cent. solution of hydrochloric acid; shake well and allow to stand for some time. If the sand is coated, the solution will have a yellowish color, the depth of color being some index of the amount of coating. If a sand which is coated is washed with hydrochloric acid and then with water, it will be found that briquettes made with such sand will have much greater strength than those made with the same sand untreated.

The mineralogical composition of sand is generally its least important qualification. Occasionally, however, this may be of considerable importance, as illustrated by the following incident: An artificial sand which was exceptionally well graded, gave very low results in the tension tests. Investigation showed that all but the very finest particles were composed of a number of finer particles very loosely cemented together. Many of them could be very readily broken up with slight pressure with a knife blade. Examination of the broken briquettes showed that the break ran through the coarser particles of sand.

The nature, grading and character of the fine aggregate seems to be very much more important than that of the coarse aggregate. However, the same considerations applied with somewhat less force, should govern the selection and acceptance of the coarse aggregate. Generally, under practical conditions, these reduce themselves to the matter of grading and all effort within the limits of economy should be directed toward securing a good grading of the coarse aggregate. Here again, however, the effect of poor grading of coarse aggregate is not nearly so marked on the strength of the concrete as the effect of poor grading of fine aggregate.

In the design and construction of the concreting plant, ready means of accurately proportioning concrete materials must be provided; and it is most essential that ready means of varying these proportions from day to day, in accordance with the determinations of the laboratory, be arranged for. It is often wise to include in the design an extra bin over the mixers in addition to the usual sand and stone bins. If this is done and if the laboratory tests show it to be desirable, small amounts of other materials may be added to the mixture. Frequently, the available sand is not well graded, but by the addition to the mixture of small amounts of crusher screenings or some other materials, the sand may be made to have an excellent grading and in this way greatly increase the strength of the concrete.

A plant designed for the use of bulk cement in which the concrete materials are proportioned by weight, lends itself readily to the logical method of proportioning concrete materials. In this case a standard foundry platform scale is used with four levers, each of which may be set for the quantity of a certain material desired. The material—sand, cement or stone—is run into a hopper mounted on the scales until the proper lever arm, which has been released by a stop, balances. Then by means of a thumb lever the load is transferred to another lever and more material run in, etc. The hopper discharges directly into the concrete mixer by means of a chute. This

method is very accurate and permits of readily varying the size of the batch, quantity of cement, or of fine or coarse aggregate. In case the proportioning is by volume, where the cement is dumped into the hopper from bags, it is necessary to vary the size of the batch in order to vary the relative quantity of cement used. A laboratory should be built either in the mixer plant or immediately adjacent to it. This is quite essential as the quantities of aggregate tested each day will be large and if the laboratory is located at a distance considerable time will be lost by the tester in taking his samples and carrying them up to the laboratory.

PULSATIONS IN PIPE LINES

In a paper presented before the American Society of Civil Engineers and published in the Proceedings of that society for October, 1917, H. C. Vensano describes some experiments and measurements of pulsations made on a long pipe under actual operating conditions. The experiments show what can be expected, practically, in the way of wave effects, and demonstrate that pulsations, whether due to gate opening or closing, can by no means be neglected in design, even for lines which are controlled by slowly moving gates.

The experiments were made by Mr. Vensano while occupying the position of civil and hydraulic engineer of the Pacific Gas and Electric Co. They were conducted at the drum power plant of the company on Bear River, in Placer County, California. This plant has two 12,500-kw. electric generators, each driven by a pair of Pelton impulse wheels. The supply for these wheels is brought to the power house in a riveted steel pipe, or penstock, 6,282 ft. long, and having a diameter of 72 ins. at its upper end and 52 ins. at the power house. The experiments were made on this penstock. Pulsations of acceleration due to gate opening and also of retardation due to gate closing were investigated. These effects were obtained by opening or closing (simultaneously) one or more of the needle nozzles which control the supply to the wheels. Owing to the fact that the time of closure for a nozzle was approximately 69 seconds, the results will apply to the conditions of slow gate closure.

The conclusions based on the experiments are given below. The nomenclature used in the formulas follows:

a = velocity of wave propagation in a pipe of uniform diameter;

a_1, a_2, a_3, a_4 = velocity of wave propagation for lengths of pipe, L_1, L_2, L_3, L_4, etc.;

b = thickness of pipe walls, in inches;

D = diameter of pipe, in inches, where line is of constant diameter;

E = coefficient of elasticity of steel taken at 30,000,000 lbs. per square inch.

g = acceleration due to gravity, in feet per second = 32.2;

h = pressure rise, or fall from normal, measured in feet of head at any point (due to pulsations);

K = voluminal modulus of elasticity of water, taken at 294,000 lbs. per square inch;

L = total length of pipe, in feet, between the point at which the pressure is desired and the reservoir;

L_1, L_2, L_3 L_4, etc. = length of sections of pipe of varying diameter, in feet, between the point at which the pressure is desired and the reservoir, L_1 being the first section, starting at the point at which the pressure is desired;

T = time of gate closure (or opening), in seconds;

V = velocity of flow in pipe of uniform diameter, in feet per second, at beginning of gate motion;

V_1, V_2, V_3, V_4, etc., = velocity of flow, in feet per second, in sections of pipe of diameter, D_1, D_2, D_3, D_4, respectively, at beginning of gate motion;

v_1, v_2, v_3, v_4, etc., = velocity of flow, in feet per second, in sections of pipe diameter, D_1, D_2, D_3, D_4, respectively, at end of gate motion;

W = weight of water per cubic foot, taken at 62.4 lbs.

Conclusions

First.—The general formula for pressure variation from normal at any point in a pipe line, with uniformly varying gate opening, should be

$$h = \frac{2\,(L_1 V_1 + L_2 V_2 + \ldots\ldots L_{x-1} V_{x-1} + L_x V_x)}{g\,T} \qquad (1)$$

This formula applies to a pipe with varying diameter.

Second.—For slow gate closure, this formula reduces to

$$h = \frac{2\,(L_1 V_1 + L_2 V_2 + L_3 V_3 + \text{, etc., for full length of pipe})}{g\,T} \qquad (2)$$

and, further, reduces to

$$h = \frac{2\,L\,V}{g\,T} \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

for slow gate closure with a pipe of uniform diameter, as advocated by Professor Joukovsky. Formulas (1), (2) and (3) are limited to a maximum value of

$$h = \frac{a_1\,v_1}{g} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Third.—As this formula indicates, the velocity of flow at the gate, or at the point where the pressure is to be ascertained, does not necessarily (of itself alone) fix the magnitude of the pressure wave at such point, but that the magnitude of the pressure wave is influenced by the varying velocities of the moving water column in all portions of the line between the point at which the pressure is to be ascertained and the reservoir.

Fourth.—Under ordinary conditions the water-hammer effect may, and does, produce as great a fall in pressure below the normal as it produces a rise above normal after the gate has been closed completely. In other words, the pressure vibrates back and forth above and below normal after gate closure.

Fifth.—In pipes of uniform diameter, the magnitude of pressure variation along the pipe line will vary directly as the time required for the wave to travel from any point in question to the reservoir and return to the same point, as advanced by Professor Joukovsky, provided the time of gate closure is greater than the half period of the pipe.

Sixth.—The effect of accelerating the water column by gate opening is analogous to the effect of retardation in gate closing, except that the pressure variations have the opposite sign. The period of pulsation is the same. The chief difference is that the wave effects die out much more rapidly with opening than with closing, and this seems also to damp the vibration so rapidly that the full magnitude is obtained only for a short time.

Seventh.—The synthetic method, used by Professor Joukovsky and Miss Simin to determine wave forms, can be used to good advantage in the study of such effects, and can be made to predict probable wave forms and magnitudes, if properly interpreted.

Eighth.—It is here found that the velocity of wave propagation in water, for riveted steel pipe, can be calculated approximately by the recognized formula:

$$a = \frac{12}{\sqrt{\dfrac{W}{g}\left(\dfrac{1}{K} + \dfrac{D}{Eb}\right)}} \ldots\ldots\ldots\ldots (5)$$

if proper allowance is made for the effect of joint details.

THE NEW CHICAGO RULES FOR DESIGN OF REINFORCED CONCRETE SLAB FLOORS

A REVISED ruling covering the design of reinforced concrete slab floors in Chicago has been issued by Mr. Charles Bostrom, commissioner of buildings for that city. The new ruling, which went into effect on January 1st, 1918, is as follows:—

Definitions

(1) Flat slabs as understood by this ruling are reinforced concrete slabs, supported directly on reinforced columns with or without plates or capitals at the top, the whole construction being hingeless and monolithic without any visible beams or girders. The construction may be such as to admit the use of hollow panels in the ceiling or smooth ceiling with depressed panels on the floor.

(2) The column capital shall be defined as the gradual flaring out of the top of the column without any marked offset.

(3) The drop panel shall be defined as a square or rectangular depression around the column capital extending below the slab adjacent to it.

(4) The panel length shall be defined as the distance c. to c. of columns of the side of a square panel, or the average distance c. to c. of columns of the long and short sides of a rectangular panel.

Columns

(5) The least dimension of any concrete column shall be not less than one-twelfth the panel length, nor one-twelfth the clear height of the column.

Slab Thickness

(6) The minimum total thickness of the slab in inches shall be determined by the formula: $t = \sqrt{W}/44$ (= square root of W divided by 44), where t = total thickness of slab in inches, W = total live load and dead load in pounds on the panel, measured c. to c. of columns.

(7) In no case shall the thickness be less than 1/32 of the panel length (L/32) for floors, nor 1/40 of the panel length (L/40) for roofs (L being the distance c. to c. of columns).

(8) In no case shall the thickness of slab be less than 6 ins. for floors or roofs.

Column Capital

(9) When used, the diameter of the column capital shall be measured where its vertical thickness is at least 1½ ins., and shall be at least 0.225 of the panel length.

The slope of the column capital shall nowhere make an angle with the vertical of more than 45°. Special attention shall be given to the design of the column capital in considering eccentric loads and the effect of wind upon the structure.

Drop Panel

(10) When used, the drop panel shall be square or circular for square panels and rectangular or ellipt'cal for oblong panels.

(11) The length of the drop shall not be less than one-third of the panel length (L/3) if square, and not less than one-third of the long or short side of the panel, respectively, if rectangular.

(12) The depth of the drop panel shall be determined by computing it as a beam, using the negative moment over the column capital specified elsewhere in this ruling.

(13) In no case, however, shall the dimensions of the drop panel be less than required for punching shear along its perimeter, using the allowable unit shearing stresses specified below.

Shearing Stresses

(14) The allowable unit punching shear on the perimeter of the column capital shall be 3/50 of the ultimate compressive strength of the concrete as given in section 533 of the building ordinance. The allowable unit shear on the perimeter of the drop panel shall be 0.03 of the ultimate compressive strength of the concrete. In computing shearing stress for the purpose of determining the resistance to diagonal tension the method specified by the ordinance shall be used.

Panel Strips

(15) For the purpose of establishing the bending moments and the resisting moments of a square panel the panel shall be divided into strips, known as strip A and strip B. Strip A shall include the reinforcement and slab in a width extending from the centre line of the columns for a distance each side of this centre line equal to one-quarter of the panel length. Strip B shall include the reinforcement and slab in the half width remaining in the centre of the panel. At right angles to these strips the panel shall be divided into similar strips A and B, having the same widths and relations to the centre line of the columns as the above strips. These strips shall be for designing purposes only, and are not intended as the boundary lines of any bands of steel used.

(16) These strips shall apply to the system of reinforcement in which the reinforcing bars are placed parallel and at right angles to the centre line of the columns, hereinafter known as the two-way system, and also to the system of reinforcement in which the reinforcing bars are placed parallel, at right angles to and diagonal to the centre line of the columns hereinafter known as the four-way system.

(17) Any other system of reinforcement in which the reinforcing bars are placed in circular, concentric rings and radial bars, or systems with steel rods arranged in any manner whatsoever, shall comply with the requirements of either the two-way or the four-way system herein specified.

Bending Moment Coefficients, Interior Panel, Two-way System

(18) In panels where standard drops and column capitals are used as above specified, the negative bending moment, taken at a cross-section of each strip A at the end of the column capital or over it, shall be taken as WL/30.

(19) The positive bending moment taken at a cross-section of each strip A midway between column centres shall be taken as WL/60.

(20) The positive bending moment taken at a cross-section of each strip B in the middle of the panel shall be taken as WL/120.

(21) The negative bending moment taken at a cross-section of each strip B on the centre line of the columns shall be taken as WL/120.

(22) In the formulas hereinabove given W = total live and dead load on the whole panel in pounds, L = panel length, c. to c. of columns.

Bending Moment of Efficients, Interior Panel, Four-way System

(23) In panels where standard drops and column capitals are used as above specified, the negative bending moment, taken at a cross-section of each strip A at the edge of column capital or over it, shall be taken as LW/30.

(24) The positive bending moment taken at a cross-section of each strip A, midway between column centres, shall be taken as WL/80.

(25) The positive bending moment, taken at a cross-section of each strip B, in the middle of the panel, shall be taken as WL/120.

(26) The negative bending moment, taken at a cross-section of each strip B on the centre line of the columns, shall be taken as WL/120.

Bending Moment Coefficients, Wall Panels

(27) Where wall panels with standard drops and capitals are carried by columns and girders built in walls, as in skeleton construction, the same coefficients shall be used as for an interior panel, except as follows: The positive bending moments on strips A and B midway between wall and first line of columns shall be increased 25 per cent.

(28) Where wall panels are carried on new brick walls these shall be laid in Portland cement mortar, and shall be stiffened with pilasters as follows: If a 16-in. wall is used, it shall have a 4-in. pilaster; if a 12-in. wall is used, it shall have an 8-in. pilaster. The length of pilasters shall be not less than the diameter of the column, nor less than one-eighth of the distance between pilasters. The pilasters shall be located opposite the columns as nearly as practicable, and shall be corbeled out 4 ins. at the top, starting at the level of the base of the column capital. Not less than 8-in. bearing shall be provided for the slab, the full length of wall.

The coefficients of bending moments required for these panels shall be the same as those for the interior panels except as provided herewith: The positive bending moments on strips A and B midway between the wall and first line of columns shall be increased 50 per cent.

(29) Where wall panels are supported on old brick walls there shall be columns with standard drops and capitals built against the wall, which shall be tied to the same in an approved manner, and at least an 8-in. bearing provided for the slab, the full length. Where this is impracticable there shall be built a beam on the underside of slab, adjacent to the wall between columns, strong enough to carry 25 per cent. of the panel load.

The coefficients of bending moments for the two cases of slab support herein described shall be the same as those specified in Section 27 and Section 28 for skeleton and wall bearing condition respectively.

(30) Nothing specified above shall be construed as applying to a case of slabs merely resting on walls or ledges, without any condition of restraint. These shall be figured as in ordinary beam-and-girder construction specified in the ordinances.

Bending Moment Coefficients, Wall and Interior Columns

(31) Wall columns in skeleton construction shall be designed to resist a bending moment of WL/60 at floors and WL/30 at roof. The amount of steel required for this moment shall be independent of that required to carry the direct load. It shall be placed as near the surfaces of the column as practicable on the tension sides, and the rods shall be continuous in crossing from one side to another. The length of rods below the base of the capital and above the floor line shall be sufficient to develop their strength through bond, but not less than 40 diameters, nor less than one-third the clear height between the floor line and the base of the column capital.

(32) The interior columns must be analyzed for the worst conditions of unbalanced loading. It is the intention of this ruling to cover ordinary cases of eccentric loads on the columns by the requirement of Section 5. Where the minimum size of column therein specified is found insufficient, however, the effect of the resulting bending moment shall be properly divided between the adjoining slab and the columns above and below according to best principles of engineering, and the columns enlarged sufficiently to carry the load safely.

Bending Moment Coefficients, Panels Without Drops, or Capitals, or Both

(33) In square panels where no column capital or no depressions are used the sum total of positive and negative bending moments shall be equal to that computed by the following formula:—

$$B.M. = (WL/8) \quad (1.53 - 4k + 4.18k^3)$$

where

B.M. = numerical sum of positive and negative bending moments, regardless of algebraic signs.

W = total live and dead load on the whole panel.

L = length of side of a square panel, c. to c. of columns.

k = ratio of the radius of the column or column capital to panel length, L.

This total bending moment shall be divided between the positive and the negative moments in the same proportion as in the typical square panels for two-way or four-way systems specified above for interior and wall panels respectively.

Point of Inflection

(34) For the purpose of making the calculations of the bending moment at the sections away from the column capital, the point of inflection shall be considered as being one-quarter the distance c. to c. of columns, both crosswise and diagonally, from the centre of the column.

Tensile Stress in Steel and Compressive Stress in Concrete

(35) The tensile stress in steel and the compressive stress in the concrete to resist the bending moment shall be calculated on the basis of the reinforcement and slab in the width included in a given strip, and according to the assumptions and requirements given in Sections 532-535, inclusive, of the building ordinance. The steel shall be considered as being concentrated at the centre of gravity of all the bands of steel in a given strip.

(36) For the four-way system of reinforcement the amount of steel to resist the negative bending moment over the support in each strip A shall be taken as the sum of the areas of steel in one cross-band and one diagonal band. The amount of steel to resist the positive bending moment of each strip B shall be considered as the area of the steel in a diagonal band. The amount of steel to resist the positive bending moment in each strip A shall be considered as the area of the steel in a cross band, and the amount of steel to resist the negative moment in each strip B shall be the steel included in the width of strip B.

(37) For the two-way system of reinforcement the amount of steel to resist the bending moment in any strip shall be considered as the area of steel included in the width of the strip.

(38) In both systems of reinforcement the compressive stress in the concrete in any strip shall be calculated by taking the area of steel considered for each strip and applying it in a beam formula based on the principles of Section 535 of the building ordinance.

(39) Where drop panels are used, the width of beam assumed to resist the compressive stresses over the column capital shall be the width of the drop.

(40) The width of beam, where no drop panels are used, shall be the width of steel bands. Where this is found insufficient, the area shall be increased by introducing compression steel in the bottom of slab.

Rectangular Panels

(41) When the length of panel in either two-way or four-way system does not exceed the breadth by more than 5 per cent. all computations shall be based on a square panel whose side equals the mean of the length and breadth, and the steel equally distributed among the strips according to the coefficients above specified.

(42) In no rectangular panel shall the length exceed the breadth by more than one-third of the latter.

Rectangular Panels, Four-way System

(43) In the four-way system of reinforcement, where length exceeds breadth by more than 5 per cent., the amount of steel required in strip A, long direction, both positive and negative, shall be the same as that required for the same strip in a square panel whose length is equal to the long side of the rectangular panel.

(44) The amount of steel, strip A, short direction, positive and negative, shall be the same as that required for the same strip in a square panel, whose length is equal to the short side of the rectangular panel.

(45) The amount of steel in strip B, positive and negative, shall be the same as that required for similar strip in a square panel whose length is equal to the mean of the long and short side of the rectangular panel.

(46) In no case shall the amount of steel in the short side be less than two-thirds of that required for the long side.

Rectangular Panels, Two-way System

(47) In the two-way system of reinforcement the amount of steel required for the positive and the negative moment of each strip A shall be determined in the same manner as indicated for the four-way system above.

(48) The amount of steel in strip B, positive and negative, running in short direction, shall be equal to that required for the same strip in a square panel whose length equals the long side of the rectangular panel.

(49) The amount of steel in strip B, long direction, positive and negative, shall be equal to that required for the same strip in a square panel, whose length equals the short side of the rectangular panel.

(50) In no case shall the amount of steel in strip B, long direction, be less than two-thirds of that in the short direction.

Walls and Openings

(51) Girders and beams shall be constructed under walls, around openings, and to carry concentrated loads.

Spandrel Beams

(52) The spandrel beams or girders shall, in addition to their own weight and the weight of the spandrel wall, be assumed to carry 20 per cent. of the wall panel load uniformly distributed upon them.

Placing of Steel

(53) In order that the slab bars shall be maintained in the position shown in the design during the work of pouring the slab, spacers and supports shall be provided satisfactory to the commissioner of buildings. All bars shall be secured in place at intersections by wire or other metal fastenings. In no case shall the spacing of the bars exceed 9 ins. The steel to resist the negative moment in each strip B shall extend one-quarter of the panel length beyond the centre line of the columns in both directions.

(54) Splices in bars may be made wherever convenient, but preferably at points of minimum stress. The length of splice beyond the centre point, in each direction, shall not be less than 40 diameters of the bars nor less than 2 ft. The splicing of adjacent bars shall be avoided as far as possible.

(55) Slab bars which are lapped over the column, the sectional area of both being included in the calculations for negative moment, shall extend not less than 0.25 of the panel length for cross bands and 0.35 of the panel length for diagonal bands, beyond the column centre.

Computations

(56) Complete computations of interior and wall panels and such other portions of the building as may be required by the commissioner of buildings shall be left in the office of the commissioner of buildings when plans are presented for approval.

Test of Workmanship

(57) The commissioner of buildings or his representative may choose any two adjacent panels in the building for the purpose of ascertaining the character of workmanship. The test shall not be made sooner than the time required for the cement to set thoroughly, nor less than six weeks after the concrete has been poured.

(58) All deflections under test load shall be taken at the centre of the slab, and shall be measured from the normal unloaded position of the slab. The two panels selected shall be uniformly loaded over their entire area with a load equal to the dead load plus twice the live load, thus obtaining twice the total design load. The load shall remain in place not less than 24 hours. If the total deflection in the centre of the panel under the test load does not exceed 1/800 of the panel length the slab may be placarded to carry the full design live load. If it exceeds this amount of deflection, and recovers not less than 80 per cent. of the total deflection within seven days after the load is removed, the slab may be placarded to carry the full design live load. If the deflection exceeds the allowable amount above specified, and the recovery is less than 80 per cent. in seven days after the removal of the test load, other tests shall be made on the same or other panels, the results of which will determine the amount of live load the slabs will be permitted to carry.

General

(59) The design and execution of the work shall conform to the general provisions and the spirit of the Chicago Building Ordinances in points not covered by this ruling and to the best engineering practice in general.

Enforcement

(60) This ruling shall go into effect on and after January 1st, 1918. All previous rulings on flat slabs are hereby rescinded.

It is stated by "La Nature" that over nine million horsepower is obtainable from French rivers for 180 days in the year. Corresponding figures for other European countries show that France is especially favoured in this respect, her water power resources being considerably larger than those of Norway, Sweden or Italy, or, in fact, of any other European country except perhaps Russia. It is also interesting to note that although the German available water resources only amount to about 1½ million horse-power per annum, she has utilized 31 per cent. of them, whereas only 10 per cent. of French water power is yet developed.

SNOW CLEANING AND REMOVAL IN OTTAWA

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City Engineer's Department, Ottawa, Ont.

SNOW removal in large cities is one of the most exacting duties of the city engineer; one that requires a great deal of study and experience if it is to be handled satisfactorily.

In Ottawa, the snow cleaning comes under the direct supervision of the commissioner of works, Mr. A. F. Macallum, C.E. The organization under the commissioner is shown in Fig. 1. This constitutes the Ottawa snow-fighting force.

The department is warned of any serious snow storm and the street superintendent is notified to be in readiness. He in turn warns his district foremen and teams by telephone (which is installed in each foreman's residence).

All sidewalks within the city are cleaned with the standard snow-plough used for this work, of which the city has forty-eight in use throughout the winter. Late each fall these ploughs are placed in convenient locations throughout the nine districts into which the city is divided.

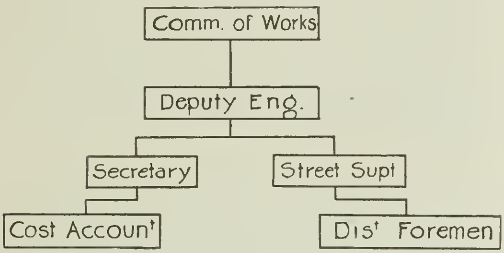

Fig. 1.—Chart of Organization

If the snow storm starts during the night the foremen and teams usually turn out about 3.30 a.m. and have the sidewalks completely cleared for pedestrian traffic by 8.30 a.m.

Should the storm be severe, the snow becomes heaped to a height of about five feet along the residential streets at the edge of the sidewalks, making sleighing difficult. In Fig. 2 is shown the "walk-away" plough, which is used in Ottawa to remedy this difficulty. This plough levels the ridges and spreads the snow evenly over the surface of the roadway. It is then rolled by a large wooden roller of 4 ft. 6 ins. diameter. This packs the snow and allows good sleighing. The snow on residential streets is never carted away.

On the business streets, or streets where street cars operate, the snow is taken to dumps located in outlying districts of the city, usually the river or canal being used for this purpose.

A clause in the Ottawa Electric Railway Company's charter with the city reads: "In the event of the Ottawa Electric Railway running cars on wheels during the winter months, the company shall at its own expense remove the snow from curb to curb from the streets on which they operate; snow to such a depth as may be required for sleighing to be left on said streets."

The handling of snow by the Electric Railway Company now is simply a matter of routine, following the development and improvement of sweepers, wing-ploughs and other snow-handling apparatus. One of the modern sweepers is shown in Fig. 3. The company owns eleven sweepers and three wing-ploughs and operates these during snow storms.

Last winter the Ottawa Electric Railway Company drew 42,500 loads of snow off the city streets. The fall of snow for that winter was 137 inches, being the record year since the inception of the Ottawa Electric Railway. After the sweepers and wing ploughs have swept the tracks clear of snow, men and teams follow. The snow boxes

Fig. 2.—"Walk-away" Plough

used by the company are on double sloops. Each snow box measures 12 feet long, 4 feet wide and 3½ feet deep. These are capable of carrying 168 cubic feet of snow. The boxes are owned by the company, and are given out to the team owners early each fall. The team owners make a contract with the railway, agreeing to turn out after each storm and draw snow at 37 cents per load, the company undertaking to load and unload same.

The sidewalks on the business streets are cleaned off by city forces. Ploughs are used first and after them a gang of men pick and shovel the snow off completely. These streets cost much more than the residential ones to clear, as will be shown by the cost schedule to follow.

When the snow on the sidewalks becomes packed by pedestrian traffic, they become very slippery. To rectify this, a scratcher is drawn over the surface. This scratcher is about 3 feet wide with prongs protruding every 4 inches.

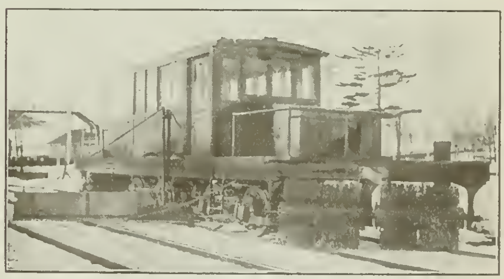

Fig. 3.—Ottawa Electric Railway Sweeper

This roughens the surface and makes walking easy. Fig. 4 shows a view of the snow scratcher as used in Ottawa. In extreme cases of alternate thawing and freezing, sand is brushed lightly over the surface of the walks. This causes the walks to become very dirty in the spring, but has been found to be the most effective method of dealing with icy conditions.

The thawing out in the spring of the accumulation of ice and snow is an expensive item for the city. Channels

have to be cut along the sidewalks to the gulleys. The gulleys, if badly frozen, have to be thawed out with steam secured from a portable vertical boiler.

The total cost of snow cleaning in Ottawa for the winter of 1916-17 amounted to nearly \$20,000, this being a decrease over the previous year of over \$8,000. This decrease was partly due to a lighter snow fall and partly to the new system introduced by the commissioner of works.

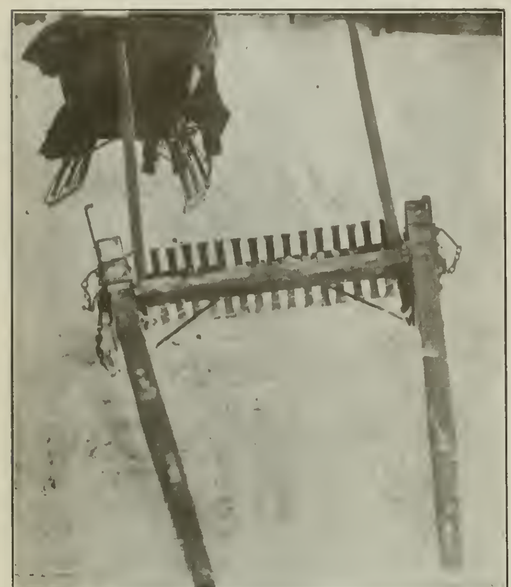

Fig. 4.—Snow Scratcher

The cost per mile for the various snow cleaning operations in the business and residential sections is tabulated below:—

	Business section.	Residential section.
Plowing	\$36.47 per mile	\$35.28 per mile
Shovelling	21.40 " "	10.87 " "
Sanding	6.66 " "	.13 " "
Scratching	4.24 " "	1.20 " "
Picking	14.56 " "	.31 " "
Repairs	.60 " "	.31 " "
Boards	.91 " "	— " "
	\$84.58 per mile	\$48.10 per mile

It will be noticed from these costs that in the business section the cost per mile is greatly increased by the labor costs of shovelling and picking.

The average cost per mile over the whole city amounts to \$72.18.

The nationalization of the Grand Trunk Pacific is considered imminent. There is some talk of acquiring the Grand Trunk Railway also along the lines recommended by the Drayton-Acworth report.

The world's production of nickel is now six times as great as in 1900. Ontario is estimated to supply 80 per cent. of this, although before the present century the French island of New Caledonia in the South Pacific, yielded 65 per cent. of the total output. The nickel deposits of Sudbury, Ontario, are incomparably the richest yet known.

OFFERS ASPHALT STILL FOR EXPERIMENTS

The Imperial Oil Company has placed its laboratory and experimental still at Montreal at the service of the Canadian Society of Civil Engineers, the province of Ontario and the province of Quebec for experiments which either of the provincial departments or the paving materials committees of the society may wish to carry out at any time.

The company has installed at its Montreal East asphalt refinery, a small still of 100 gallons capacity. This still duplicates exactly the refining process of the large stills, which hold charges of about 200 tons each. Distillation can be carried on in the small still under steam, air or vacuum, as desired, and to produce asphalts or road oils of quality identical to those refined commercially. The company has made the offer of its equipment in the belief that carefully run tests in a still of this kind would yield considerable information that would tend to improve the asphaltic road oil specifications of the provinces and also the tentative specification now being considered by the Canadian Society of Civil Engineers.

The company offers to supply the crudes necessary for the experiments, or the officials making the experiments can obtain their own crudes from any sources desired. The preparation of specifications as the result of experiments made in such manner would link up laboratory work with the results of commercial production in a way that would be productive of the best results, as it is impossible to duplicate commercial distillation with the ordinary type of laboratory equipment.

The provinces of Alberta and British Columbia have recently been connected by a road following the route to the south of Crow's Nest Lake, which has resulted in abandoning the old road over the summit at Crow's Nest Pass. The new road passes by easy grades over the summit of the Canadian Rockies, on the boundary line between Alberta and British Columbia. In addition to this, there are now a number of roads throughout the Kootenay District in British Columbia which are under construction.

The Hon. Mr. Allard, Minister of Lands and Forests, has introduced two important by-laws before the Legislative Assembly at Quebec. The first will offer facilities for the floating of pulp logs on rivers where there are dams or barrages. The companies, owners of slides at any such dam, are empowered to collect taxes from other companies to which such slides are profitable. Their control was previously under the direction of the Department of Public Works, Quebec. In the future, it will be under the direction of the Hon. Minister of Lands and Forests, who has now a competent staff to manage this department. The second by-law is an amendment to the Civil Code by which all the lakes and navigable waters will be considered as being in the domain of public lands.

Advantage over other large magnets of simplicity of construction is claimed for the powerful magnet of Dr. Svedburg, of the University of Ursala, Sweden. The rectangular frame, 30 by 22 inches, is built up of four bars, the cross-section being 6 by 3 inches, and is fixed to a cast-iron base permitting it to be used in a horizontal or vertical position, or the whole magnet can be suspended by a hook. The two cylindrical pole-pieces, bolted to the frame's short sides so as to face each other, have each a diameter of 6 inches, a length of 9 inches, and half-inch avial bore. The windings of each pole-piece consists of six cylindrical coils of twelfth-inch copper wire, fitting over one another, and so separated by brass water-jackets that no part of the 4,500 turns of wires is more than a quarter-inch from the cooling water. Working with the laboratory's continuous current of 450 volts, the magnet takes about 20 amperes. The pole gap can be varied between about ¾ inch and 3 inches, its diameter between 1 and 6 inches; and with an air gap ¾ inch long and an inch in diameter, the maximum field intensity may be 21,500 Gauss. The magnet, weighing 1,300 pounds, is separable into six parts for transportation.

Letters to the Editor

Provincial Consulting Engineering

Sir,—Mr. Thomas Adams' letter, published in your issue of January 24th, states that I was the only engineer who objected "to the proposal to have more skilled engineering advice on provincial authorities." This sounds heinous, but in reality it resolves itself into a question of interpretation of terms, and I contend that my objection was well-founded.

Mr. Adams stated that "Until there is a skilled municipal department in each province to advise and help local authorities with engineering advice, we cannot expect satisfactory improvement in the status of the municipal and sanitary engineers."

In another part of his letter he quoted as follows: "In view of the great issues and large expenditure involved it is of urgent importance to Canada that each province should have a well-organized municipal department with expert advisers on all kinds of municipal affairs. One of the special tasks of such a department would be to advise and assist small municipalities."

Mr. Adams spoke on this matter at the Hamilton convention and my objection was based upon the question of a government department giving advice and assistance, which I asked should be more fully explained by him. Would they be purely suggestive or would they be practical, such as municipalities could operate upon? Would the government have a number of experts for water, sewage, electric, roads and other works?

If skilled engineering advice and assistance was to be given gratuitously, I contended that it would militate against engineers who had devoted their life's energy to qualify for this purpose as a livelihood. This will sound as if there was a vested interest in the municipal engineering profession.

Free advice and help would perhaps be appreciated in proportion to its cost; or municipalities would perhaps recognize its value and fail to appreciate the necessity of employing engineers at all.

I am confident that Mr. Adams does not advocate free and generous practical help to municipalities, but in the absence of a specific definition of what he means, it is reasonable to expect those who are not familiar with Local Government Board practice, to anticipate a practical paternal governmental assistance, and this is actually what some think it means.

Free advice and help must necessarily carry with it some measure of provincial responsibility and enforcement, otherwise its elemental virtue would disappear. The adoption of this method of provincial assistance would tend to lead to stereotyped ideas and lack of progressive development with the times. We have seen something of this nature in connection with war supplies, and it needed Mr. Lloyd George to eradicate the evil by organizing a convulsive national co-operation scheme.

Mr. Adams states that he has seen the profession of consulting engineer become strengthened in the Old Country as the result of the more extensive use of the official engineer. In this statement I agree, but the Local Government Board of England and Wales, so far as my experience went, does not give free advice and help, but insists upon competent men being employed. I have conferred with several of the Local Government Board engineers and whilst they are certainly able and agreeable men, they were diffident in giving any advice. Their tion is judicial and not advisory. Mr. Adams has had experience with the Local Government Board but perhaps as town planning was new and the number of experts in that work was limited, some help and advice may have been given.

I am certainly not averse to the employment of skilled engineers in connection with provincial departments of municipal affairs. I have persistently advocated this during the last few years. It is only necessary to refer to the files of *The Canadian Engineer* and other papers, from 1912 forward, to find articles of mine on this subject. I strongly advocate the establishment of Local Government Boards on British lines for each province, for there is no doubt that they would do much to promote higher efficiency in municipal undertakings. They would not hamper the municipalities, but would constitute excellent bulwarks against ill-advised, ill-designed and oft-times unwise schemes and expenditures of public money.

The editorial in question has brought forth and made more public many excellent suggestions which Mr. Adams advocates. It also contained pointers which deserve the attention of municipal engineers — both officials and practitioners.

No engineer will doubt Mr. Adams' sincerity and ability, nor question his advocacy that they should be more fully recognized and employed. This is what we are agitating for and which makes us restless—sometimes. It is to be regretted that we have so few men of Mr. Adams' stamp in the profession who, in season and out, hammer on the anvil of public opinion. A group of men, possessed of the same spirit of persistency and insistency would create some stir and achieve some improvement. But we are such a massive body, dignified and conventional, that it requires something revolutionary or volcanic to make us move together.

The present conflict is one in which engineers play a predominant part, and this is admitted by the thinking public, and yet by reason of the conservatism and modesty of engineers, they accept the situation—in the rear—whilst politicians and others, far less worthy, shine like stars in the firmament and are admired by the thoughtless whilst the sun whose brilliancy is reflected, is hidden out of sight.

Until engineers as a coherent body bestir themselves to demand and insist on our occupying the position to which we are entitled and for which we are qualified, so long shall we continue to be "hewers of wood and drawers of water" for those whose aspirations are more pronounced and for the public which through our fault fail to appreciate fully our services and our merits.

R. O. WYNNE-ROBERTS,
Consulting Engineer.

Toronto, Ont., February 1st, 1918.

Similarity of Weir Flow

Sir,—I desire to thank you for the very excellent manner in which you have reproduced in your issue of January 17th last, the paper recently read by me before the American Society of Civil Engineers, entitled "Ice Diversion, Hydraulic Models and Hydraulic Similarity." Moreover, my interest in the issue of *The Canadian Engineer* referred to above is greatly intensified by certain considerations connected with the abstract from The Cornell Civil Engineer, which you give on page 60, *et seq*, of the very interesting article by Mr. Jacob O. Jones, entitled "The

Effect on Orifice and Weir Flow of Slight Rounding of the Up-stream Edge."

It appears to me that I find thereby a surprising, if not most remarkable, corroboration of the theory of similarity of flow treated in my own paper. It is worthy of note that you should have printed these two papers in one issue of *The Canadian Engineer*.

If the two elements, geometric and hydraulic similarity, are caused to maintain in the operation of two hydraulic models, velocities will be found to be proportional to the square roots of homologous linear dimensions. This implies that velocities at different points in the same model will have the same relative magnitudes among themselves that the corresponding homologous velocities have in a model of different size.

It follows from these considerations that if we have two similar weirs of different sizes with rounded upstream edges and compare their discharges with a sharp-crested weir under the same head, when the heads on the rounded weirs are proportional to homologous radii of the roundings we should find in each case the same percentage of excess discharge above that for a sharp-crested weir under the same head.

Of course, the thickness of the plates out of which the weirs are made should also be proportional to the radii of the rounding in order to create a perfect condition of geometric similarity, and a similar statement should be made as to all other dimensions of the weirs, such as height, breadth, etc. In these latter respects the conditions of Mr. Jones' experiments are not quite right for the comparisons to be made, but it is evident that they do not have much effect and cannot change the conclusions much. Possibly the thickness of the plate, being constantly ⅛ in. in all cases may make itself slightly felt; but not sufficiently to vitiate the comparisons.

Referring now to page 42, of the Construction News Section of your issue of January 17th last, Mr. Jones adopts the formula

$$P = k\frac{R}{H^n}$$

as giving the percentage excess over the discharge of a sharp crest; k being a constant, R the radius of rounding, and H the head on the weir. If the theory of similarity is reasonably near the truth the exponent, n, should be unity if H is made proportional to R in any two cases to be compared, whereas Mr. Jones derives the value ¾. This neglects the effects of thickness of weir plate, etc., as mentioned above, which might in part account for the value ¾ instead of unity.

However this may be, we are entitled to omit all formulas and take the results of the experiments, as shown by Fig. No. 2, page 61. In making the comparison, certain of the curves show irregularities and these may be postponed until after the best curves have been considered. Take for example, the intersection of the curve of .30 foot head and the vertical for .02 inch rounding. The intersections for other similar weirs with heads proportional to radii of rounding are as follows:—

Heads, H	.20	.40	.50	.60	.70	.15
Radius, R ...	.0133	.0267	.0333	.040	.0466	.010

If these points be plotted on the diagram of Fig. No. 2, reserving the last for further consideration, it will be found that the points all lie at about the same elevation along the straight line, indicating 1.15 to 1.20 per cent. excess. Other ratios of head to radius might be treated similarly with similar results. This is the corroboration of the theory of similarity indicated.

One may now revert to the points of intersection of the curve of .15 foot head with the vertical of .01 inch radius. Instead of plotting this point, however, we may proceed to determine a more correct point on the .15 foot head curve by projecting the 1.175 (average of 1.15 and 1.20) percentage horizontal upon the .01 inch vertical, the intersection being shown by x on the diagram. This is a point of the .15 foot head curve and it is undoubtedly located much more exactly than any of the nearby points on the plotted curve, thus determining a more likely location for the curve at this part of the diagram.

It is a remarkable proof of the accuracy of Mr. Jones' measurements which is shown by the relationship existing in his tests between the measured head and measured radius of the rounding of the upstream edge.

B. F. GROAT.

Pittsburg, Pa., February 2nd, 1918.

"Possible Engineering Legislature Enactments."

Sir,—In reference to the article in your issue of January 17th on the discussion of the Manitoba Branch of the Canadian Society of Civil Engineers on "Possible Engineering Legislature Enactments." The question dealt with is a very big one and a very important one to the engineering profession in Canada and so is worthy of the fullest consideration by every member of the profession.

It would appear that the Manitoba Branch discussed, on the same evening, two subjects—the resolution of the Calgary Branch concerning legislation and the report of the society's committee on society affairs dealing with the change in the name of the society and the change in by-laws. Presumably this accounts for the resolution which was passed by the Manitoba Branch, which after concurring along broad lines with the Calgary resolution, went on to deal with the bringing in of kindred organizations, the change in name and the enactment of new by-laws.

Mr. Legrand's comment is most interesting and instructive but it is felt that it should not be allowed to rest as it is without further remark and explanation.

As to Mr. Legrand's first note that the wording of the resolution referred to seemed to show that the majority of the members were not quite clear as to what precisely constitutes an engineer and desired legislation to define the qualifications necessary for an engineer. It is felt that one could properly make this statement much stronger and say that no engineer or anybody else is clear on this point. Certainly if one reads the daily and periodical press one feels quite certain that the public is not clear on the point. And how can they be, for one day they read of an engineer who is a locomotive driver, on another day of an engineer who builds ships on the Clyde, and again of one who runs a stationary engine. And if one turns to the dictionary, the array of definitions is not very clear and each dictionary consulted gives a different definition. So, treating the point on this purely academic ground, it would seem that we are entitled to a definition and certainly a Dominion-wide law is the proper source from which to seek it.

The writer remembers very well, a little instance that happened when travelling through Colorado a few years ago. The usual group was seated on the rear end of the observation car and prominent among them, the tourist who commented on everything as we went along. The train stopped at a small station where a section of double track was being laid and within twenty or thirty feet of the rear end was a gang working on excavation. The side hill was springy and everything was mud, the dirt was being taken out by hand and loaded on a little dump wagon drawn by an old mule. The gang was most non-

descript in appearance and included a nigger and a mexican. It was a dirty job and the tourist took it all in. Finally, as the train started on again, he heaved a sigh of relief and exclaimed, "My, but I am glad I'm not one of those engineers."

And then the statement "that the definition of the qualifications of an engineer was not the only advantage expected from legislation." Certainly not; but there is no hidden joker, as a reading of these words might imply. The legislation is sought as a means to an end. And the end is a proper recognition by the public of the part the engineer has taken and must in the future take in building up the Dominion, and of the responsibility that rests on the engineer in providing efficient and safe works and utilities for the public. And a legal status that will, insofar as possible, ensure that the engineer has the proper qualifications to make him worthy of this recognition and capable of assuming the responsibility and properly discharging the high duties imposed upon him.

One senses the insinuation that legislation is sought to create a close corporation or a trade union that would willy nilly increase the engineer's wages. This is not the desire. The engineers want a reasonable legal protection of the profession and after will sell their services on the open market.

Mr. Legrand's notations of the essential features of the proposed legislation are agreed to in the main. But it is not at all clear why he suggests a governing body composed of *legal* men. The report, accompanying the final resolution on this subject, passed by the Calgary Branch and the Alberta Division, laid stress on the radical idea suggested of forming a governing body not controlled by the engineers themselves. This was done essentially with a view to dissipating all suspicions of the close corporation idea. But the original suggestion did not contemplate a governing body of *legal* men, and it is hard to understand why they should be. The suggestion was a governing body, comprised in a Board of *Engineers* controlled by the science faculties of all recognized universities in Canada. The report referred to explained that it seems proper that the control of those who may practice the profession should in some degree be placed in the hands of those institutions of learning which are maintained by the government or by the public to teach the fundamentals of the science of the profession. The idea suggested would seem to give control by a most desirable co-operation between those most highly trained in theory and those most highly trained in practice.

And again, commenting upon Mr. Legrand's last paragraph. If every engineer had the high ideals which he sets forth, one would be inclined to agree with him that no legislative enactment is needed. But is this not a Utopian idea? Is it reasonable to assume or even hope that all engineers will practice these high ideals? To-day any man can call himself an engineer and it takes only a few black sheep to color the whole flock. We want to bring about the organization of a class of men, such as is indicated, and the suggestion is that the only way it can be done in practice is by the strict enforcement of a Dominion-wide law.

One is not inclined to agree with the last statement, referring to the effect of legislation on the other professions. And certainly if there is truth in it, the engineers asking for legislation now should be able to benefit by whatever faults may exist in the present legislation governing other professions and might expect to obtain their legislation with any of the objectionable features expunged.

F. H. PETERS, M.Can.Soc.C.E.

Calgary, Alta., January 29th, 1918.

Engineering Legislative Enactments

Sir,—In the article, "Manitoba Engineers Discuss Possible Legislative Enactments," published in your paper for January 17th, 1918, the third of the main clauses which I suggested to be included in legislation should have read as follows:—

"3rd. The appointment of a governing body composed of leading men," etc.

The use of the word "legal" instead of "leading" was an error in the typewriting of my copy. It was certainly not my intention to mix legal men with our engineers. I, among many, think the legal men already are encroaching too much on the engineering profession.

J. G. LEGRAND,
Bridge Engineer, G.T.P.

Winnipeg, Man., January 29th, 1918.

ASSOCIATION OF DOMINION LAND SURVEYORS, ANNUAL MEETING

The annual meeting of the Association of Dominion Land Surveyors was held in Ottawa on the 30th and 31st of January and 1st February. The following officers and committees were elected for the ensuing year: President, J. N. Wallace, Calgary, Alta.; vice-president, J. R. Akins, St. Catharines, Ont.; secretary-treasurer, E. W. Hubbell, Ottawa, Ont.; executive committee, G. H. Blauchet, J. L. Rannie, W. H. Norrish; publication and publicity, E. M. Dennies, H. G. Barber, C. Engler, F. H. Kitto; topographical surveys, H. L. Seymour, J. D. Craig, E. J. Wight, W. H. Norrish; Dominion land surveys, J. W. Pierce, J. R. Akins, S. D. Fawcett, R. C. Purser, F. W. Rice, J. M. Cote; advisory committee, G. J. Lonergan, A. M. Narraway.

The organization is in a satisfactory position as to membership and finances in spite of the heavy draft on both through the large number of men on active service overseas.

Hon. Arthur Meighen, Minister of the Interior, the speaker at the luncheon, dealt with the effects, present and future, of the war on the work of surveying, particularly in connection with colonization work. Mr. Noulan Cauchon, also of the Department of the Interior, and a well-known town-planning engineer, spoke on the increasing interest shown by the provincial governments, several of which have passed town-planning laws, and the opportunity open to surveyors in this new profession. The matter was taken up by the association and referred to one of the standing committees for consideration and such action as might be taken pending the next meeting.

The convention was open to the public on the first evening. H. L. Seymour spoke on the subject of colonization and settlement schemes, dealing with methods of survey and the history of town-planning in Canada.

Other subjects dealt with were: "Field Photography and Map Reproduction," by H. K. Carruthers, official photographer of the Topographical Survey; "Survey Methods," by W. H. Norrish, G. C. Cowper and J. W. Pierce; a paper on the financial end of surveying by T. E. Brown; and a talk on first aid by Dr. W. O. Gliddon.

A tentative price of $90 an ounce has been set by the United States government for the purchase of 21,000 ounces of platinum recently imported from Russia.

The summary of the mineral production of British Columbia for 1917 shows a decided increase for the precious metals and lead, but a great decrease in the production of copper and zinc.

ROAD IMPROVEMENT IN NEW BRUNSWICK

By L. L. Theriault, A.M.Can.Soc.C.E.
District Road Engineer, Fredericton, N.B.

LAST year the province of New Brunswick fell in line with the Good Roads Movement and the legislature of 1917 placed the Permanent Roads Act on the statute books.

The direct revenue from the automobile licenses not being sufficient to carry on this work—being only $61,000 in 1917 and probably $90,000 this year under the revised schedule—it was decided to place this amount into a fund to provide for an issue of serial bonds for half a million dollars a year until such time as the direct revenue could provide for this expenditure.

The total mileage of trunk roads of primary importance in this province is approximately 1,000 miles, with about 1,000 miles of secondary importance. These roads extend from Matapedia to St. Stephen, following the shore line, and those radiating from Fredericton to Edmundston, to St. Stephen, to St. John, to Richibucto and to Newcastle. Seventy-five per cent. of this mileage is through sandy and sandy loam soils, the remainder through clay and heavy loam, very little rock being encountered.

Fortunately for the provincial finances, the meaning of permanent roads here is not so formidable as it looks, because the main factors to be considered are climate and drainage, traffic being only of secondary importance, as not more than 50 miles carry a maximum traffic of 600 vehicles per day and over, around St. Stephen, St. John and Moncton.

The present trunk road system has been located in a rather haphazard way—along the line of least resistance—the alignment being poor in places, but the grades are generally good, so that few diversions will be required for easier grades and the alignment could not be conveniently changed, having due regard to the requirements of the settlements through which these roads are located.

A rapid condition survey of the trunk roads was made at the beginning of the season by the district engineers in automobiles, to report on the general conditions of the soil, drainage and surface estimates of the season's repairs and maintenance, and locate the sections for permanent work. These parties covered up to thirty miles per day, at an average cost of $1.10 per mile.

In previous years all road work, except bridges, had been done and superintended by local road supervisors, whose main qualifications were political patronage, and whose ideas of road making and maintenance were as numerous as the number of sections in the province. The results of this deplorable policy were roads that could serve as fair foundations for road improvements, but in most cases a poor substitute for travelled highways.

Under the Permanent Roads Act, a provincial road engineer was appointed and district road engineers with field staffs under their direct control to direct the activities of the local road superintendents and supervise the sections of permanent work under construction.

The mechanical equipment consists of ten 7-ton and ten ¾-ton White motor trucks, used in fleets of two or three units, 210 road machines, steel champion grade, distributed through the different parishes, 10 road levellers, 130 drag scrapers, 50 wheel scrapers, 60 road ditchers and graders, 1 tractor and 10 wagons; with a varied assortment of smaller tools, ploughs, picks, shovels, etc., and 250 split-log drags.

Out of a total of $334,000 charged to permanent roads at the end of the fiscal year, $220,000 were actually spent in roadwork, the remainder being used to purchase motor vehicles and Martin road graders. Forty-five miles of improved roads were completed in different districts, at a cost of $150,000, the balance of the money being used for work not completed and various repairs to the trunk roads.

The general cross-section of the improved roads is 26 feet between ditches, 20-foot roadway with from 8 to 30 inches metalling crowned ¾ inch per foot, broken stone foundation where obtainable, otherwise gravel was used, and a gravel surface. The only rolling done was by traffic and the 7-ton trucks loaded. All wooden culverts were replaced with 15-inch to 30-inch concrete pipes with end walls of concrete or masonry.

No particular difficulties were met with where the foundation soil was sandy and sandy loam, but some sections were carried across peat bogs, heavy clay, salt-water marshes, and swamps, where special care was needed. The Shippigan barren road in Gloucester County is through a peat bog, three miles in length, 8 to 20 feet deep. This peat bog is wet all the year round, owing to seepage from numerous small lakes or ponds in the barren. The old road, built twenty years ago, was only 14 feet wide on a corduroy foundation. This foundation was still in good condition; it was covered over with a 6-inch mat of spruce boughs extending four feet beyond each end of the corduroy and the improved road built over, 22 feet wide, with 12 to 24 inches of pit gravel. The 7-ton trucks were too heavy to be used safely on this road and only the light ones and teams were employed. The gravel was deposited in layers 6 inches thick and consolidated by traffic for two or three weeks before the next layer was placed. At the east end of the barren 500 feet of the road was below high tide level and here 30 to 36 inches of gravel was required. Where needed, wooden box culverts, 2 ft. x 3 ft. on piles were used. Ditches were carried on both sides 3 feet wide by 1 to 3 feet deep, sloped 1 to 1 on the inside and sodded. The average haul for gravel was 1.2 miles, the pit containing coarse sand and fine gravel, with 50 per cent. of coarse gravel, special care being taken to have the finer material for surface. This work cost $9,000 per mile, exclusive of engineering expenses, which would not be over 3 per cent.

The Beresford Road, near Bathurst, in Gloucester County, is five miles long over heavy clay foundation; brush mats had to be used in different places, one-half mile in all; the metalling consisted of 8 to 18 inches of pit gravel, found near the roadway, the average haul being 0.8 mile; 40 yards of field stones were required for dry walls in places to protect the embankment against scouring by freshet water in the ditches; 126 feet of 18-inch concrete pipe and 132 feet of 24-inch were used to replace the wooden culverts. This section cost $1,200 per mile. The traffic here, as well as on the Shippigan barren road, would average 250 vehicles per day, with a maximum of 400.

The Musquash Marsh Road in Westmorland County, one mile long, is over a salt-water hay marsh. The old brush mat foundation, 2 feet thick, was still in good condition, covered with worn gravel surface. Hard gravel was spread and rolled 8 inches thick with the 7-ton trucks. The roadway was made 26 feet wide and in places rows of 4-foot stakes had to be driven in the shoulder, to prevent sliding. There was not sufficient grade for proper drainage through the side ditches and an offtake drain 1,100 feet long had to be excavated through the marsh. Gravel was obtained from a pit at one end of the marsh which contained a large percentage of ferriguneous and flinty material with very little clay and sand.

Those places where rock cuts and blasting were required were nearly all left over for next season,—not over 200 cubic yards of rock being removed this season.

The province does not yet claim to have built permanent roads—only improved ones, which, however, will serve for the foundation of permanent work in the future, when the financial situation will be in better condition. A large part of the expenditures during a few years yet will have to go towards permanent bridges, to replace the present old wooden ones now inadequate for the traffic they have to carry, and many of them having served their time.

The operations during 1917 were more of a reorganization and preparatory nature than definite construction, while in 1918 a more concentrated program will be followed.

The provincial road engineer's plans for 1918 call for an expenditure of at least $250,000 on different sections of road not over 100 miles in total length under direct engineering organization, provided the new federal regulations regarding the issue of bonds does not prove a hindrance in procuring the necessary funds for this undertaking.

CANADIAN WAR TRADE BOARD

It was announced from Ottawa last week that the Dominion Government had decided to create a War Trade Board composed of the following well-known business and financial men:—

Frank P. Jones, general manager of the Canada Cement Co.; J. W. McConnell, president of the St. Lawrence Sugar Refining Co.; J. H. Gundy, of Wood, Gundy & Co., bond dealers; Chas. B. McNaught, of Reed, Shaw & McNaught, insurance agents; and Joseph Gibbons, representing organized labor.

The Minister of Trade and Commerce, Sir George Foster, will act as chairman. C. A. Magrath and Hon. H. Laporte will be members ex-officio, the former as fuel controller and the latter as chairman of the war purchasing commission.

The powers and duties of the board are officially announced as follows:—

(1) To have direction of licenses for export and to make recommendations with regard thereto.

(2) To have direction of licenses for import and of applications to the proper authorities of exporting countries for permit to export to Canada, and to make recommendations with regard thereto.

(3) To undertake and carry out such supervision as may be necessary of all industrial and commercial enterprises, and by co-operation with producers to prevent waste of labor, of raw materials and of products.

(4) To make recommendations for the maintenance of the more essential industries as distinguished from those of a less essential character.

(5) To investigate and keep records of the country's stock of raw materials, partly finished products and finished products, and when necessary to direct their distribution so as to obtain the best results in the national interest.

(6) To consider and recommend methods of curtailing or prohibiting the use of fuel or electrical energy in the less essential industries.

(7) To direct priority in the distribution of fuel, electrical energy, raw materials and partly finished products.

(8) To investigate generally conditions of trade, industry and production (except food production), and to make recommendations with regard thereto.

(9) To work in co-operation with the Canadian War Mission at Washington, and, through that Mission or otherwise, to co-operate with the War Trade Board of the United States, or other bodies constituted for the like purpose, with a view to securing the most effective unity of action by the two countries for war purposes.

It is provided that any department of the government may attach to the board such of its officers as may be deemed advisable.

The board is to co-operate with the several departments of the government in any matter requiring common or united action, and each department is to assist and co-operate with the board and its officers.

The order in Council creating the board also contains a proviso that nothing therein shall take away or affect the powers of the food controller. It contains a further proviso that for the present the powers of C. A. Magrath as fuel controller and of Sir Henry Drayton as controller of electrical energy shall continue pending further arrangements as to united control and direction in both fuel and power.

An official statement issued by the Prime Minister declares that the board is constituted, "following very careful consideration of more effective organization for the purpose of the war, and having regard to the necessity of more effective measures for maintenance of industries essential for that purpose."

PROPOSAL TO CONSERVE WATERS OF THE GRAND RIVER

Before the Associated Boards of Trade of Brantford, Kitchener, Fergus and Galt, Noulan Cauchon, A.M.Can. Soc.C.E., outlined on Thursday last a plan of development for what is known as the Metropolitan District, which embraces all territory between Kitchener and Hamilton.

Mr. Cauchon in the course of his address emphasized the fact that by his plan for storing the waters of the Grand River, three very important objects would be obtained. First, the prevention of floods by the conservation of the water in storage dams; second, the irrigation of approximately 100 square miles of territory; third, the production of several thousands of horse-power of electrical energy.

He referred to the two vital necessities of the present time, namely, greater production of food stuffs and greater power. He claimed that the increase in production due to his irrigation scheme would be enormous.

The plan as outlined by Mr. Cauchon very favorably impressed the delegates, and on the motion of Mr. Joseph Ham, M.P.P., of Brantford, seconded by D. B. Detweiler, of Kitchener, the Galt Board of Trade was authorized to prepare a resolution setting forth the meeting's approval of the need and practicability of the scheme, this resolution to be sent to the Hydro-Electric Power Commission of Ontario, and also to the Minister of the Interior at Ottawa.

Other defects besides those of the human body may be revealed by X-rays, and recent experiments indicate that they may give very accurate tests of reinforced concrete, bringing to notice any deterioration from time to time. X-ray photographs of slabs several inches thick caused even the structure of the concrete to be shown as well as the condition of the quarter-inch iron rods. By injection under pressure of some bismuth solution, any existing openings were made opaque, and even the finest cracks were thus brought out in the pictures.

FALLACIES IN INVESTIGATION OF WATER SUPPLIES*

By H. A. Whittaker
Director, Division of Sanitation, Minnesota State Board of Health.

FOR many years laboratory workers have been developing analytical methods for the detection of pollution in water, and these investigations have resulted in the establishment of standard methods for this purpose. It is a well-known fact that these methods, when properly applied, form an important part of a routine water supply investigation. It is also recognized that a thorough field survey is absolutely essential before a reliable opinion can be offered regarding the safety of a supply for drinking purposes. Unfortunately, certain health departments have been depending largely on an analysis of the water, without obtaining first-hand information regarding the environmental, structural and operative features of the water supply.

A common practice is to leave the field work to untrained individuals in the local communities. Data sheets and sampling equipment are often furnished to local authorities and private citizens, who collect the field data and water samples on which the safety of a water supply is determined. There are several points in connection with this practice that are dangerous to public safety. By this method the field survey, which is one of the most essential parts of the investigation, is placed in the hands of an untrained observer who is often incompetent to undertake the work. The same unskilled individual is entrusted with the duty of securing samples of water that must be properly collected if satisfactory analytical results are to be obtained. These samples are then forwarded to the laboratory and subjected to most careful examination by skilled technicians when there is no assurance of the accuracy of their collection. This method makes it necessary for the skilled worker to accept facts from an untrained person on the fundamental features of an investigation on which the safety of a water supply is to be judged.

This practice is often the result of a desire on the part of health departments to extend their services to the public, without considering the dangers associated with this method. Frequently these departments are short of funds to carry on field surveys, and this method is provided as a substitute for more thorough work. After the public is educated to such procedure, it becomes very difficult to refuse the examination of samples collected by anyone from every conceivable source.

In 1903 the Minnesota State Board of Health recognized the fallacy of attempting to investigate water supplies by this method, and since that time has required that the field and laboratory work in connection with these investigations be undertaken by trained representatives of the board.

The 569 investigations undertaken represent both surface and underground water supplies from a variety of sources, including wells (dug, bored, drilled, driven), springs, lakes, rivers, creeks, etc. The need for water supply investigations in this state is shown by the fact that 344, or 60 per cent. of the samples examined, were found to be unsatisfactory in their existing condition. An analysis of the results of these unsatisfactory supplies brings out the fact that 180, or 52 per cent., were shown to be unsafe by both the field survey and analytical results; 136, or 40 per cent., by the field investigation alone, while the analytical results on the date of the investigation were satisfactory; and 28, or 8 per cent., by the analytical results alone, where the field investigation did not show the possibilities of pollution at that time, and further investigation was required. These results show that the field survey was corroborated by the analytical results in 52 per cent. of the cases; that the field survey was the only index of danger in 40 per cent.; and the analytical results the only index in 8 per cent.

These results bring out very forcibly the importance of thorough field work, for had the analytical results been accepted as the only index, 40 per cent. of the unsatisfactory supplies would have been approved. It is also true that had the analytical work been omitted, 8 per cent. of the unsatisfactory supplies would have been overlooked. It is evident from these results that both a field and analytical investigation should be made before an opinion is given as to the safety of a water supply from a sanitary point of view. The field survey should give an accurate idea of the possibilities of present and future pollution, while the analytical results should provide information on the sanitary condition of the water at the particular time the investigation is made, and may furnish some information on the past history of the water. The field survey and analytical results together should afford information on which recommendations can be made for the protection or abandonment of the supply. It should be thoroughly appreciated that the use of any method in the investigation of water supplies which provides for the collection of haphazard information by untrained individuals is a dangerous practice.

*American Journal of Public Health.

ACTIVATED SLUDGE DEFINED

In the definition of terms used in sewerage and sewage disposal practice, submitted to the Sanitary Engineering Section of the American Public Health Association in October, 1917, by the Committee on Sewerage and Sewage Disposal, the following definition of activated sludge appears:

"Activated-sludge process is the agitation of a mixture of sewage with about 15 per cent. or more of its volume of biologically active liquid sludge in the presence of ample atmospheric oxygen, for a sufficient period of time at least to coagulate a large proportion of the colloidal substances, followed by sedimentation adequate for the subsidence of the sludge flocculi; the activated sludge having been previously produced by aëration of successive portions of sewage and maintained in its active condition by adequate aëration by itself or in contact with sewage."

As a result of exhaustive inquiries made by the Minister of Lands in conjunction with the Western representative of the Imperial Munitions Board, the government of British Columbia has passed an order-in-council empowering its representatives to arrange for the immediate logging of aeroplane spruce upon all vacant areas of Crown land and calls upon holders to proceed with the necessary operations. This policy will result in the tapping of valuable resources and is expected to yield approximately 30,000,000 feet per month.

If it had not been for scientific research the Germans would have been without explosives and the war would have ended long ago, according to Dean Adams, of the Faculty of Science at the McGill University, a member of the Dominion Advisory Council of Industrial and Scientific Research, who addressed the Royal Canadian Institute at Toronto on Saturday evening last. He charged Canada with being prodigal in her efforts and resources and urged research, co-operation and conservation.

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Principal Contents of this Issue

MONTREAL'S GOVERNMENT

Those who have had at heart the best interests of the city of Montreal will be gratified at the decision to place the government of the city with a commission. This commission will be composed of the chief city attorney, the comptroller and auditor, the city treasurer and two other members to be named by the lieutenant-governor-in-council. The last two will be named for four years and the first three for life unless they cease to work for the good of the city of Montreal. The city council of mayor and twenty aldermen will be retained but with reduced powers. The commissioners will sit in the city council and have votes. The reports of the commissioners can be rejected only on a two-thirds or three-quarters vote of the aldermen. The board of control will be abolished.

These are steps in the right direction. As Sir Lomer Gouin, Premier of Quebec, stated last month to the private bills committee of the provincial legislature, the city of Montreal is at the commencement of its development and will be one of the greatest cities in the world. It must have a business-like and honest administration. Its credit must be raised to a high plane. Sir Lomer truly said that it is necessary for a city, as for an individual, to have not only assets and hopes, but also good credit. Montreal has substantial assets and a great future. It possesses capital, but it is necessary that the city should acquire better credit.

There will continue to be a mayor of the city. The premier of Quebec was asked last week what the mayor's powers would be, and replied to the effect that the mayor would occupy the very dignified position of representing the city in the city and outside, to receive visitors, "like the Lord Mayor of London," as Sir Lomer put it. The comment of Mayor Mederic Martin, of Montreal, is reported to have been, "I leave Quebec and I will never come back," which, of course, is more or less of a disaster for Quebec.

AFTER THE WAR

In the principal belligerent countries, are active signs of preparation for the period to follow the war. This does not indicate that peace is any nearer, save for the fact that the war is nearly four years old. The activity is based on the assumption that the struggle must cease one day and that then will come the problems of reconstruction, of land settlement, transportation, trade and business generally. This will prove a critical period in many ways but it will also be an era replete with interest for the engineer and business man.

In Germany, some attention has been given to post-bellum problems but so far as we can gather, the postponement of defeat and disaster is almost fully exercising the ingenuity and activities of that nation. In Japan, where war participation is not so clearly defined, there is a marked advance in the gathering of commercial information, with a view to capturing trade formerly done by other countries. This has resulted already in a considerable increase in Japanese exports to a number of important markets. While the United States has immense work in the organization, equipment and transportation of its expeditionary forces, and in the maintenance of its war industries, attention is being given there to preparations for the post-bellum period. In Canada we, too, find the war task dominating but work is being done in many directions to prepare for the time to follow the final truce.

The United Kingdom, upon which has fallen such a heavy financial and general burden for more than three and a half years of war, has excited the admiration of its Allies by the practical steps it is taking with a view to future trade. Its war load is tremendous but that it will remain a very powerful commercial nation after the war, despite the drain of the struggle, the heavy national debt, and the loss of manpower, is quite certain. Every week almost we hear of the appointment of important committees to deal with post-bellum matters. It is now stated that the minister of reconstruction has established, in conjunction with the treasury, a committee on financial facilities after the war, the object of which is to anticipate and provide methods to overcome the financial difficulties that will arise in connection with commerce and industry. The vast number of factories which have been diverted from their normal trade to war work will face a critical period between the time when hostilities cease and the time when it is possible for them to return to their pre-war activities, for an interval more or less lengthy must occur during which it will not be possible to revert to former productiveness, while the question of cost in restoring factories to conditions formerly prevailing will require careful consideration and preparation of plans to provide the necessary money and capital.

Apart from that aspect, there is the certainty that largely increased costs of raw materials, higher wages, and a much greater value of stock in hand or on credit will have to be met, requiring fresh capital, while longer credit may be necessary.

PERSONALS

G. H. Davis has been appointed acting resident engineer, Toronto Terminals.

Lieut. Percy Roberts, of the Canadian Engineers, formerly connected with the Harbor Board at Montreal, has been mentioned in despatches by Sir Douglas Haig.

William R. McCully, late aircraft motor engineer of the Packard Motor Car Co., Detroit, is now affiliated with the aircraft division of the Willys-Overland Co., at Elmira, N.Y., and Toronto, Ont.

Lieut. A. G Leslie, B.A.Sc., '13, Lieut. "Conn" Smythe, B.A.Sc., '16, and Lieut. B. McClenaghan, class '18, are University of Toronto science men who have recently been awarded Military Crosses.

A. E. Warren, assistant general manager, Western Lines, Canadian Northern Railway, Winnipeg, has been appointed chief operating officer for the Federal Railways Department Office, Western Departmental Block, Ottawa.

Lieut.-Col. Andrew McNaughton, B.Sc., '10, of McGill, formerly lecturer on the science staff, who has been serving in France on the artillery staff of the Canadian Corps in charge of counter battery work, has been awarded the D.S.O.

Lieut George H. Ferguson, B.A.Sc. '06, University of Toronto, A.M.Can.Soc.C.E., serving in France with the 11th Field Company, Canadian Engineers, has been awarded the Military Cross. Prior to going overseas he was hydrological expert for the Commission of Conservation at Ottawa.

Lieut.-Col. W. P. Anderson, C.M.G., M.Can.Soc. C.E., chief engineer, Marine and Fisheries Department, Ottawa, a veteran of the Fenian Raids, has three sons who have been made members of the Distinguished Service Order. They are Col. W. B. Anderson, Lieut.-Col. T. V. Anderson, and Major Alex. Anderson.

G. R. Jongkins, superintendent of motive power, Canadian Government Railways, is reported as about to retire after some months of absence on account of illness. During his absence W. N. Appleton, general master mechanic, has been acting superintendent and W. E. Barnes, master mechanic, has been acting general master mechanic.

OBITUARIES

William Allan Foley, who was superintendent for Goldie & McCulloch Co., Galt, Ont., for some years, died in that city on January 27th in his seventy-fifth year.

Samuel Newmarch, a prominent railway contractor, died suddenly at his residence at Beaconsfield, B.C., on February 2nd. He was born in Montreal but has been in Winnipeg and the west for many years. He was superintendent of the construction force sent from Canada to build the road at Kola Bay, Russia.

SCIENTIFIC AND INDUSTRIAL RESEARCH

The Research Council, at a meeting held recently at Ottawa, considered a number of important questions connected with Canadian industries. A memorandum was forwarded to the government urging that immediate action be taken to make available the varied fuel resources within the boundaries of the Dominion for the use of the people of Canada in the coming year and placing the services of the Research Council at the disposal of the government to that end.

A grant was made for the purpose of carrying out an investigation into the utilization of the immense quantity of sulphite liquor which is now thrown away as a waste product of the pulp mills of Canada, with a view to the establishment of certain new industries with this material as a raw product. The utilization of the waste ammoniacal liquor from Canadian gas works was also considered, this product containing large quantities of ammonia which is of great value as a fertilizer.

The council, at the request of the Institution of Civil Engineers of Great Britain, also took steps to bring before the government and certain manufacturers of Canada the importance of Canada's associating herself with the movement which has recently been organized in Great Britain, the United States and France for combined action in connection with the standardization of various engineering products used in and exported from these countries. This is a matter of great importance in the building up of an export trade in this class of products by Canada at the close of the war.

It was decided also to approach the Canadian Manufacturers' Association on the question of the development of trade organizations for the promotion of research, etc., in connection with groups of industries, such organizations having been developed with most beneficial results in Great Britain and in the United States. Co-operation along these lines is of the highest importance if Canada is to be able to hold her own in the keen competition which will develop in foreign markets with the cessation of hostilities.

The Council decided to issue to the public a series of short bulletins dealing with some of the more important questions regarding the raw materials and certain manufacturing problems concerning which inquiries are being made at the present time.

O.L.S. ANNUAL MEETING

The annual meeting of the Association of Ontario Land Surveyors will be held February 19th, 20th and 21st in the lecture room of the Engineers' Club, Toronto. This will be the twenty-sixth annual meeting of the Association, which was incorporated in 1892. The officers are: James J. MacKay, Hamilton, president; Herbert J. Beatty, Pembroke, vice-president; T. B. Speight, Toronto, chairman of council; and L. V. Rorke, Toronto, secretary-treasurer.

The first session will open at 2 p.m. Tuesday, February 19th, with the president's address, to be followed by committee reports and papers on "Town Plan of Ojibway," by Owen McKay; "Town Planning Act," by T. D. LeMay; and "Survey Monuments," by J. W. Pierce.

Other papers on the programme for the following sessions are "Toronto and Hamilton Highway," by H. S. Van Scoyoc; "Road Development in Ontario," by C. R. Wheelock; moving pictures of road construction, by George Hogarth; "Problems Met With in Practical Surveying," by William W. Perrie; "Descriptions," by R. R. Grant; "Smooth Rock Water Power Development on Mattagami River," by E. W. Neelands; "New System of Surveys in Western Canada," by J. K. Benner; "Drainage Works," by W. G. McGeorge; and "Development in Northern Ontario," by J. F. Whitson.

Wednesday evening, February 20th, an informal dinner will be held at 7 o'clock at the Engineers' Club. Thursday noon a veterans' luncheon will be held for surveyors who received their final certificates prior to 1887.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Survey Monuments

Permanent Posts of Iron, Bronze and Concrete Now Supplanting Buried Tokens—Paper Read Before the Association of Ontario Land Surveyors

By J. W. PIERCE
Dominion and Ontario Land Surveyor

A MONUMENT has been defined as an object fixed in the soil, whether natural or artificial, and referred to in a document, and used as evidence for the delineation of boundaries or the situation of a particular plot of land.

Possibly too little attention has, in the past, been paid to this most important part of a surveyor's duty, and it is the purpose of this paper to discuss some of the more common types of monuments in use heretofore, with their advantages and disadvantages, and to describe some improvements that have been introduced.

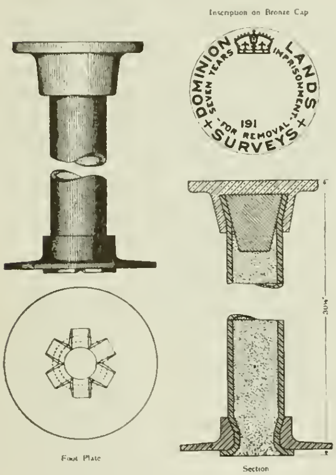


Fig. 1. Standard Survey Post

Fig. 2. Short Survey Post for planting in rock

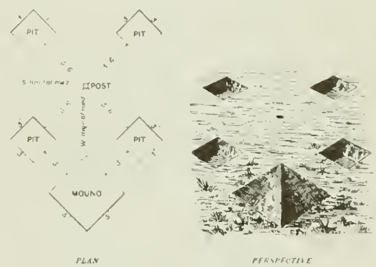


Fig. 3. Monument at township or section corner defining four sections

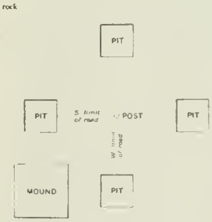


Fig. 4. Monument at township or section corner for south side of correction line.

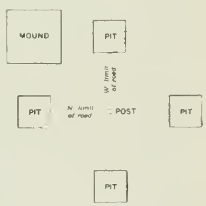


Fig. 5. Monument at township or section corner for north side of correction line.

Until comparatively recently, on ordinary land surveys in Ontario, the wooden post or a tree marked for a post has been used exclusively, due to the readiness with which posts of this material may be everywhere procured, and to the ease with which they may be set in place. Monuments of this class, when made of proper material and firmly planted, are without doubt very satisfactory for a short time after erection; they are readily located and easily interpreted, and if they were only more permanent, they would be ideal. Doubtless, the expectation of those responsible for the use of this type of monument was that it would remain in place until such time as the owners had entered into possession of their lands, after which it would naturally appear that the duty of preserving the monument would fall on those immediately interested. Unfortunately, landowners in this country pay little or no attention to the preservation of monuments, with the result that after a lapse of a few years, the great majority of our monuments are lost, in many cases beyond recovery. It is not necessary to point out to land surveyors the multitude of grave evils that are the direct result of lack of permanence of our early, and unfortunately to a great extent, our present type of monument.

There is apparently little room for doubt that it is not good practice to plant these very temporary monuments at the time of survey and leave their perpetuation to others in later years, and it is interesting to note the various departures from the plain wooden post that have from time to time been introduced with a view to making monuments more permanent.

In some of the foreign countries, and in fact in some of the earlier surveys in provinces in this country, it was customary to bury pieces of crockery, glass or other per-

manent material under the post, and in this connection we find the following instructions in the United States Manual of 1871: "Besides the charcoal, marked stone, or charred stake, one or the other of which must be lodged in the earth at the point of the corner, the deputy surveyor is recommended to plant midway between each pit and the trench, seeds of some tree (those of fruit trees adapted to the climate being always preferred), so that in course of time should such take root, a small clump of trees may possibly hereafter note the place of the corner. The fact of planting such seed and the kind thereof are matters to be truthfully noted in the field book."

In a very instructive paper prepared by Mr. Seymour on various forms of Dominion Lands Survey's monuments and read at the annual Dominion Land Surveyors' meeting a year ago, the following "true story" published in the Engineering News was quoted: "Called on to locate a certain corner that had been established many years ago, a surveyor of repute found that his nearest known starting point was some eleven miles away. The survey party commenced operations with every care, and at last, according to calculations, the desired corner was reached. The picket was jammed down into the earth with the expectation of coming into contact with the 'deposit,' but nothing seemed to be encountered. What could be wrong? The surveyor commenced to carefully check his calculations, but soon gave a joyous shout; the old notes explained that in the absence of other suitable material, a grindstone had been buried. The picket had gone right through the hole in the grindstone." Mr. Seymour aptly remarks that this shows to what degree of accuracy these old surveys were carried out.

There is no doubt that many surveyors have encountered similar experiences when endeavoring to locate obliterated corners and may recall remarks made by their clients to the effect that when they had a surveyor here forty years before, he didn't go to all this trouble in hunting up a corner; he simply measured over from another post and stopped when he had gone the right distance, kicked around in the leaves and found the post. Apparently some of our very early surveyors were men of an entirely different calibre to those of the present day.

So far as I am aware, it has never been the custom in this province to perpetuate monuments in the manner just referred to, although from a very early date our surveyors have recognized the necessity of doing more than merely planting a single wooden post. For years the position of a post has been referenced by means of bearing trees; in a great many cases surveyors have gathered stones and boulders and built a mound around the post, in other cases the old maxim "that there is safety in numbers" has been called into use, and instead of one post, three are planted at lot corners and five at the intersection of road allowances. Indeed, in some cases surveyors were unable to limit themselves to five posts. An examination of some of the original notes reveals the fact that in certain townships three rows of three posts, or nine in all, were planted at these intersections. In our present nine-mile township this system of posting is still in use, and in cases where the road allowance along a river or lake intersects the intersection of a concession and side road, you have your day's work right there. In many of these cases, our most experienced surveyors are unable to agree among themselves just where posting should be stopped and how some of these posts should be marked, and when we consider that these posts are often put in place by chainmen who are not always infallible, it is occasionally a source of speculation in camp as to whether this method of posting is the best and most efficient that could be evolved.

In after years, when one has occasion to work in this system of survey, it is not uncommon to be shown the position of one, only, of these posts with nothing to indicate which of the three, or five, or nine, as the case may be, it is. In cases such as this, it is only necessary to remark that the surveyor's troubles are often only commencing.

The disastrous effect of forest fires has been recognized to the extent that in our later surveys in Northern Ontario, surveyors have been supplied with supplementary iron posts which are planted at stated intervals throughout the township, such as the corners of a three-mile block, but no step, except a legal measure, has been taken to safeguard the post from loss through wilful removal or tampering through idle curiosity. It is common knowledge that in new country especially, survey lines are usually used as the first roads and consequently many persons who have otherwise no interest in monuments, are brought in contact with them, frequently to the detriment of the monument.

Until recently, subdivision surveys have been carried on in the provinces of Manitoba, Saskatchewan and Alberta under conditions entirely different to those obtaining in our own province, and the method of posting has necessarily also been different. Over a great portion of the West, it was impossible to obtain material to make wooden posts such as ours, and various types of monuments have been in use, the most common being the iron bar set midway between four pits; or in bush, the iron bar at the north corner of a mound five feet square, the mound itself being midway between four pits, each three feet square and eighteen inches deep. The iron posts used weighed about three pounds each, were made from piping two feet six inches in length, pointed at one end and squared at the other on which the marks were made with a cold chisel. It might be noted here that no lines are surveyed in the centre of a road allowance, but always along the side, and that one row of posts only is erected. Thus, instead of planting a post at the angle of every parcel of land separated by a road allowance, one post only is planted and the other corners located from it.

It has been recognized that this system, admirable as it is compared to that in our own province, is not sufficiently permanent and that posts were too often tampered with and lost, necessitating frequent re-surveys. Similar conditions apparently prevailed in the United States, which led to the adoption in 1910 of a post, the specifications of which are as follow: "Standard wrought iron pipe, three-quarters of an inch inside diameter, one inch outside diameter, three feet long, one end split and spread forming two foot plates, brass or composition metal cap, consisting of eighty-five parts copper, eleven and one-half parts zinc, two and one-half parts tin and one one part lead, five-sixteenths of an inch thick to lap three-quarters of an inch on pipe and flush on the end, so as to leave no space between cap and end of pipe and firmly riveted thereto; cap to be lettered as indicated, with cast letters indented. A space one inch in diameter to be burnished in order to show stamping of marks more clearly; inside of pipe to have concrete core and bottom of pipe to have rivet, bolt, or wire to secure core. Core to be of Portland cement and sand in equal parts; pipe to be coated, while hot, inside and out with mineral asphaltum rubber coating."

During the first year of the war the Surveyor-General of Dominion Lands carried on correspondence with the Commissioner of the General Land Office at Washington and also asked the various land surveyors then employed

for their suggestions and criticisms, which has resulted in the adoption of a new model iron post for Dominion Land Surveys based on that used in surveys of the public lands of the United States, which has just been described.

This post consists of a standard wrought iron pipe one inch in diameter, thirty inches in length to the top of which is fastened a bronze cap three inches in diameter. The cap, instead of being riveted to the pipe, as in the United States model, has in the latest model a cast-iron cone inserted in it, and the end of the pipe is forced into the annular space between the cone and the cap, forming a very tight fit. The composition of the cap is ninety parts copper, five parts tin, four parts zinc and one part lead. A malleable iron foot-plate three and one-half inches in diameter with a hole smaller than the diameter of the pipe, is forced over the other end of the pipe, which has first received six equally spaced saw-cuts, after which the cut parts are bent down, thus insuring that the foot plate will neither move up nor down along the post. The whole post then receives a protective coating by being dipped into a vat of Mexican asphaltum, after which the pipe is compactly filled with a cement mortar consisting of equal parts of Portland cement and sand. After the cement is set, the face of the bronze cap is cleaned off with gasoline.

These posts weigh about eight pounds and are packed in basswood crates, ten to a crate, the total crate weighing eighty-five pounds. They cost the government last year $11.10 a crate f.o.b Winnipeg, or $1.11 each. Two years ago they cost around 70 cents each.

In planting, it is necessary to dig a hole thirty inches deep to receive the post, after which the earth is tamped back around the post so that the bronze cap only is exposed and is flush with the surface of the ground. The post is placed midway between four pits and in bush country the earth from the pits is formed into a mound. Various methods are in use for planting the post. In soil free from stone or frost, the ordinary post-hole augur is satisfactory, but in ordinary bush country where roots, stones and frost are encountered, in addition to greater difficulty in regard to transportation, an iron bar and the spade are most satisfactory.

The bronze cap comes with the inscription of Dominion Lands Surveys, the penalty for the removal and the crown in addition to a centre mark, and the chainmen are supplied with a set of seventeen dies in a leather belt, similar to a cartridge belt, which are used to stamp on the section numbers, township, range and date. Under ordinary conditions a party of two mounders will erect from four to six of these mounds per day.

In rocky country, where the rock is at the surface or within twelve inches of the surface, a special post is used. This post is entirely of bronze, the top being identical with that of the standard post from which a seven-eighths inch shank projects for three inches, the weight being under a pound. In planting this post a hole is drilled in the rock three inches in depth and filled with a paste composed of a mixture of Portland cement and water, into which the post is pressed. The necessary cement is supplied in small water-tight tins and special drills are used. The drills are well suited to the purpose; they are light and will stand for two or three holes in the very hardest of granite. When dull, they are returned to the head office for re-sharpening. A five-pound hammer has been found most suitable and the length of time necessary to plant a post in rock is seldom over twenty minutes, the average being nearer fifteen. It may be mentioned here that the rock posts are in great favor with the surveyors, who now would sooner make rock monuments than those in earth.

For use on townsite surveys, a post similar to the thirty-inch standard post but somewhat shorter and of less expensive construction is provided.

Surveys on which this method of posting is used are being carried on in the West under conditions identical with those in Northern Ontario, *viz.*, bush country through which the pack strap and canoe offer the only means of transport, and an ordinary subdivision party will, under these conditions during a season, survey four hundred miles of subdivision and plant six hundred of these posts.

The advantages of this type of monument are so apparent as to scarcely need enumeration, the principal points being increased permanence and greater uniformity of practice among surveyors in erecting monuments. After the post is in place, it is almost impossible to remove it, except by digging, and it is also inconspicous. It does not invite needless attention; in fact, nine out of ten persons in passing these monuments will, while they at once notice the pits and mound, pass the post, unless they have occasion to look for it in particular. When, however, it is necessary to locate the exact corner, one may approach the corner with every assurance that the post is in place.

When this model of post was first introduced, it occasioned serious misgivings in the minds of the Dominion Land Surveyors as to its practicability and considerable speculation was indulged in, particularly with regard to its weight, extra transportation necessary, difficulties likely to be encountered in its installation and increase in labor. Now, after three years of successful operation, it is apparent that these fears were to a great extent groundless, and it is safe to say that, under ordinary conditions, the additional extra help necessary on a survey party due to the change in the type of monument does not amount to more than one man. The Dominion Land Surveyors have heartily endorsed this post, and it is very questionable whether there are any among their number who would voluntarily return to the old type in use prior to this.

In this province, railway facilities are now such that transportation problems are slight in comparison to what they were as late as ten years ago, and there would appear little reason to prevent our following the lead of the United States General Land Office and of the Dominion Lands Surveys, and to investigate whether it would not be advisable to adapt posts of this nature suitable to our own use, on government surveys, as well as on townsites, municipal surveys and in general local practice.

An extract from an article published in the Year-book for 1916 of the Swedish Chamber of Commerce, says:—"The utilization of the abundant water power of Sweden has from year to year become of greater importance as a lever in the extension of its industry and development. Until, however, the Swedish Water Power Association was formed, towards the end of 1909, there was no uniformity in the methods adopted for dealing with the problem. One great drawback experienced was the over-rating of the water power as a direct source of income and subject for taxation, while another was a movement towards limiting the rights of strandowners to the disposal of the water, under cover of which the water-power utilization industry had up to then been developed. To increase the knowledge of the water power in Sweden, the association has compiled comprehensive statistics, and has issued special survey maps based thereon. It has also arranged water-power exhibitions, where the Swedish water-power technicalities and the progress of the Swedish water-power industry have been illustrated by numerous collections of drawings, photographs, statistical tables, etc. In recent years, the association, which now comprises 260 private members, 100 commercial undertakings, 12 societies and other corporations, and six foreign societies and corresponding members, has specially endeavored to prepare for an increased consumption of water power, with the view of lessening Sweden's dependence on fuel from abroad."

WATER SUPPLY AND SEWER SYSTEM FOR CAP DE LA MADELEINE, QUEBEC

By Romeo Morrissette
Three Rivers, Quebec.

DURING the past two or three years the village of Cap de la Madeleine, Quebec, has been favored with the establishment of several important industries, which has meant an increase in the population of the village of nearly 4,000 people. Up to the present time no water system had existed at all and the municipality was

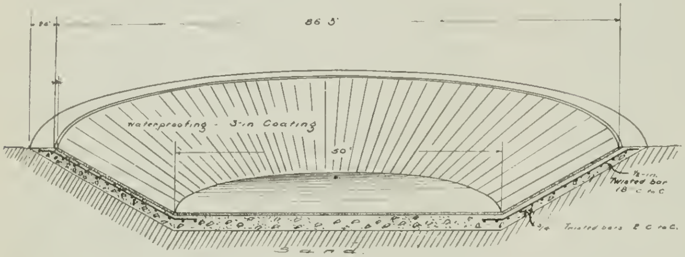


Fig. 1.—Section of Reservoir

recently confronted with the necessity of going on with the work at a time when it was most difficult to secure money for that purpose. However, a franchise was granted to Mr. Alphonse Aubin to build such a plant, the company under agreement undertaking to construct the whole system at their own risk and expense, the municipality reserving for themselves the right of buying from the company within sixty days after its acceptance by the municipal council or at any time within five years.

If the municipality takes the plant over within sixty days, the specified price to be paid is the cost of the system of unit measurement. If, however, they do not exercise their option until after the sixty days have passed, but within the five years, the price to be paid is the capital represented by the revenue of the system at that time on a basis of 5 per cent. interest. The plant was designed by Mr. J. F. Greenan, of Chicoutimi, Que., who acted as engineer for the company, while the municipality engaged Mr. G. C. Bastien, of Three Rivers, to look after their interests.

A preliminary survey served to show that the geological conditions consisted of a stratum of sand on top of a stratum of blue clay. Borings were made with the following results: For two feet below the surface of the earth a stratum of gray sand exists; for the next ten feet, gravel; for the next two feet, fine sand; below this there is a deep stratum of blue clay.

It was decided to sink wells and pump the water from these wells into a water main, thence to a reservoir, the latter designed and placed so as to permit the return of the water by gravity. The water thus secured is soft, pure and cold, and is practically free from bacteria.

Pumping Plant

The pumping plant consists of a building 18 ft. x 24 ft., one story high with concrete floors 12 ins. thick except under the pumps, where the thickness is increased to 15 ins. The pump house is designed to accommodate two centrifugal pumps, with a capacity of 450 gallons a minute under a head of 125 feet. These pumps are to be connected to electric motors. Only one of the pumps is now in place, but the other one is to be installed at an early date. The pump has a 6-inch suction pipe and the inlet pipe extends eastward for a distance of approximately 125 feet. This pipe may be lengthened if necessary. Every 10 feet, pipe wells were driven into the soil along the inlet pipe, centre to centre on one side and alternating 2 feet on the other side. Water is found at about 7 feet below the ground. The discharge pipe is also 6 inches in diameter and is attached by a "T" to a 10-inch main and to an 8-inch pipe which leads to the reservoir. The system of valves is controlled directly from the pumping station. By closing the valve in the 10-inch main, and the valve in the outlet pipe near the pump, and leaving the other open, the reservoir can be emptied for purposes of cleaning or repairs. If the pump should need repairs the valve in the outlet pipe is closed and the reservoir supplies the water by gravitation. The reservoir is situated on a hill, 60 feet above the pumping station and 80 feet above the lowest level of the system and 6,300 feet from the village.

The Reservoir

The reservoir is of a circular type, having a diameter of 86 feet at the top and a diameter of 50 feet at the bottom, with a vertical height of 10 feet. The capacity is 235,000 gallons.

The sides and bottom are made of 1:2:4 concrete 24 inches thick covered by a 3-inch layer of waterproofing grout composed of the same preparation in the mixing of concrete as was used in the reservoir itself, to which was added 10% of Toch cement. Reinforcement in the sides consists of ½-inch steel bars on 18-inch centres, placed lengthwise, while twisted steel bars, 24 inches centre to centre, were placed circularly to the basin. No reinforcement was used in the bottom of the reservoir except with the side reinforcing extended 3 feet from the side. (See Fig. No. 1.)

Pipe Laying

The construction involved the placing of 12,080 feet of 8-inch pipe, 16,540 feet of 6-inch pipe, 821 feet of 4-inch pipe, and 3,956 feet of 2-inch pipe, making a total distance of open trench of 33,400 feet. The contract for the trench digging was awarded to Messrs. John Bouvin, W. Binette & Co., Pronovost, at 25 cents per cubic yard. The average depth of the trench was 6 feet with a width of 2 feet 5 inches at the bottom. For the laying of the pipe the price was 8 cents per lineal foot; the pipe itself cost approximately $60 per ton and was supplied by Messrs. Therreault & Racine, Quebec.

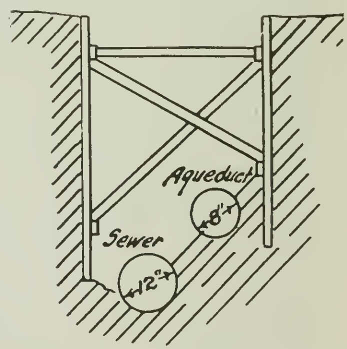


Fig. 2.—Showing Arrangement of Water and Sewer Pipes

About 20 pounds of lead were used for the joints, where the diameter was 8 inches; where the diameter was 6 inches, 15 pounds, and where the diameter was 4 inches, 10 pounds. Forty-six hydrants were placed along the system, the cost being about $75, while 45 valves were installed, costing approximately $40 each.

Wherever possible, advantage was taken of the work done for the water supply to place the sewer system. Vitrified clay pipes were placed alongside the water mains as per determined gradient from 20 per cent. to 2 per cent. and converging by gravity towards the outlets, two of which were in the River St. Maurice, and one in the St. Lawrence.

Manholes and Catch Basins

Forty-two manholes were placed. The bottoms of these manholes were 30 inches square and the upper part of elliptical form with radii 18 x 24 inches. They were built of concrete and cost about $45 each to construct. The catch basins, of which there were 15, consisted of 20-inch vitrified clay pipe placed vertically.

MANITOBA STEEL AND IRON CO., LIMITED

The organization meeting of the Manitoba Steel and Iron Company, Limited, was held in the city of Winnipeg last week and the following directors were elected: T. R. Deacon, H. B. Lyall, Sir Augustus Nanton, Geo. F. Galt, G. W. Allan, K.C., M.P., Sir Douglas Cameron, Chas. Pope, Capt. Wm. Robinson and W. H. Cross.

At a subsequent meeting of the directors, T. R. Deacon was elected as president; H. B. Lyall, vice-president; and Walter Stuart, secretary.

The company has been incorporated with a Dominion charter, with an authorized capital of $500,000, to take over the merchant end of the business of the Manitoba Bridge and Iron Works, which has grown to considerable dimensions.

The new company will carry on a general merchant business in heavy steel goods such as structural steel, plates and sheets, bar iron and steel, boiler-tubes, rivets, bolts, railway supplies, mining equipment, heavy forging billets and stock for shipbuilding. A block of land with suitable warehouse has been secured on Logan Avenue, Winnipeg, with railway siding facilities. Business will be commenced on March 1st.

The Manitoba Bridge and Iron Works intend to confine their business to purely manufacturing, for which this change will afford them more needed room on their present site. The latter company is also applying for a Dominion charter with an authorized capital of $1,000,000.

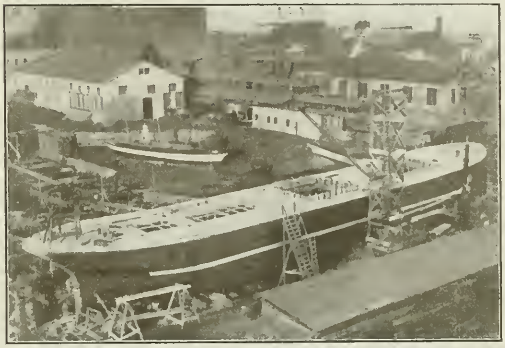
QUEBEC BRIDGE LECTURES

Two lectures on the Quebec Bridge were delivered recently in Toronto. A few weeks ago, Geo. H. Duggan, chief engineer of the St. Lawrence Bridge Co., addressed the Canadian Institute in the University School, Bloor Street, and last week Lieut.-Col. Chas. N. Monsarrat, chairman and chief engineer of the Board of Engineers, Quebec Bridge, addressed the Toronto Branch of the Canadian Society of Civil Engineers in the Chemistry and Mining Building of the University of Toronto. Both lectures were well illustrated with lantern slides. Col. Monsarrat said that error of only 1/64 inch in 50 feet was allowed in the fabrication, and that for such heavy work the accuracy obtained by the contractors was most remarkable. The greatest error found in the joints in the field was 25/1,000ths of an inch, and, when riveted complete, 4/1,000ths of an inch. The alignment of the bridge was found to be perfect.

CONCRETE BOAT AT MONTREAL

Work on the equipment of the concrete boat at Montreal is progressing rapidly and it will be ready for a trial run early in the spring. The accompanying illustration gives an excellent idea of the size and outlines of the boat. It is being built by interests associated with the Atlas Construction Co., Limited.

The completion of the vessel was delayed by an accident last fall. When being launched, the ways collapsed at one end, leaving the boat half in water and half on land. A firm of experienced Montreal shipbuilders had contracted for the launching, but apparently there was some hidden weakness in one of the timbers forming the ways. The ground was excavated between the boat and the water,



Concrete Boat at Montreal, Before Launching

and jacks were used to force the vessel into the water. This jacking put the concrete under greater strain than any for which it was designed, and was an unusual test of the strength of the hull. No permanent damage resulted from the accident, as the builders state that there is not a crack. The boat is now afloat.

The concrete shell varies in thickness from 3 to 5 inches between the ribs, which are structural steel, spaced 27 inches apart. The keel is structural steel. The boat is 125 feet long, 22 feet beam and 13 feet deep. It is intended for service on the Great Lakes and was undertaken, it is said, chiefly as an experiment to determine the rapidity with which concrete hulls can be built and the cost of such construction.

The Chilean Government has placed an order for twenty engines with the Montreal Locomotive Works, a subsidiary of the American Locomotive Works. The Canadian company is now completing an order of twenty engines for the Union of South Africa.

The suit brought by Brennan & Hollingsworth, engineers and contractors, Hamilton, against the city of Hamilton for extras entailed in the construction of sewers for the Kenilworth Avenue subway drainage, has been settled by the city's paying $2,500 to the contractors and assuming all legal costs.

There are, at the present time, 32 Heroult electric furnaces in Canada and 22 of other types—in all 54 furnaces using the electric process. These furnaces have a capacity of 173,000 tons of iron and steel, 50,000 tons of ferro-silicon, and 8,000 tons of other ferro-alloys per annum. The British Forgings plant at Toronto has ten electric furnaces of the Heroult type and a total capacity of 60 tons per heat, or about 72,000 tons per annum, making it the largest electric-process steel plant in the world.—Official Bulletin of Commission of Conservation, Ottawa.

IMPACT—THE EFFECT OF MOVING LOADS ON RAILWAY BRIDGES*

By W. S. Kinne
Associate Professor of Structural Engineering, University of Wisconsin

MOST engineering structures must be designed to carry more or less moving, or "live" load in addition to a certain amount of immovable, or "dead" load. The calculation of stresses due to any set of immovable loads is a comparatively simple matter: as soon as the loads themselves have been determined, the principles of statics can be applied and the resulting stresses readily obtained. But the calculation of stresses caused by moving loads is not so simple. This is because the rapidity with which the live loads are usually applied produces stresses which are greater than the stresses which would be caused by equal dead loads. The additional stresses due to the effect of the velocity are known as impact stresses.

The usual method of calculating stresses due to live load is to divide them into two parts. One part is obtained by considering the moving loads as a set of fixed loads, and calculating the resulting static stresses. The other part, which represents the effect of the velocity of the moving loads, is determined by increasing the static stresses by a certain percentage, known as the impact percentage, or impact coefficient. Total live load stresses are given by the sum of the static and impact live load stresses.

In any class of structures where the stresses due to impact form any considerable part of the total stresses, it is necessary to know, within reasonable limits, the effect of rapidity of application of the loads, for the final results are uncertain to the extent that the impact stresses are uncertain. Railway bridges are a large and important class of structures which come under this head. This article will deal only with impact in this class of structures.

Unfortunately, no exact method has been devised which will give a general expression for the coefficient to be used in calculating impact stresses. The attempts made to determine the impact coefficient can be classed under three general heads, as follows: First, mathematical methods; second, empirical methods; and third, experimental methods. As a general observation on the results obtained by these methods, it can be said that the first method is not very satisfactory, because the mathematics involved becomes so complex that only the simplest cases can be treated. The second method also is unsatisfactory, as empirical formulas generally are based on the personal opinion of the designer. Probably the most satisfactory method is the third. If tests could be made on all classes of structures under all probable loading conditions, a very close estimate could be made of the maximum impact stresses which would have to be provided for. At present the greatest real progress has been made along this last-named line.

Direct observation on existing bridge structures has shown that the chief factors in causing impact are: (1) Rapidity of application of live load, (2) unbalanced locomotive drivers, (3) eccentric wheels, (4) deflection of beams and stringers, which gives rise to variations in the action of the vertical forces, (5) flat or irregular wheels, and (6) rough and uneven track. Of these causes of impact the last two give impact which is in the nature of a sudden blow upon the structure. The other causes are more in the nature of a varying load, or a series of impulses, acting on the structure.

The efforts of mathematicians to develop an expression for the impact coefficient have been confined largely to the first of the causes of impact mentioned above. A small amount of mathematical work has also been done on causes two, three, and four. As the conditions are complex, no very definite results have been obtained. Causes five and six, when considered to be similar to a suddenly applied load, can be shown to produce a maximum impact stress equal to the static stress. This conclusion holds only for very short spans, or for localized conditions, such as joint details.

In making the mathematical analysis for the first cause of impact given above, it has been necessary to assume very simple initial conditions. The assumptions made are that the track is perfectly smooth, the abutments rigid, and that the moving load is a single load with the rotating parts in perfect balance. If the straight beam AB of Fig. 1 be supposed to carry a rolling load, which moves slowly across the beam, the deflection, greatly exaggerated, will be somewhat as shown by the curved line ACB. The path of the moving load is then along a path ACB. If the load be considered as moving with great velocity, its motion in a curved path will cause a centrifugal force to be set up, which tends still further to increase the deflection. This added deflection is a measure of the impact effect due to the rapidity of application of the moving load. The resulting equations are rather complicated and they will not be given here. For a discussion of this subject the reader is referred to the discussion in "Secondary Stresses in Bridge Trusses," by C. R. Grimm. A similar discussion is given on page 525 of "Modern Framed Structures," Part II., where values for the impact coefficient have been worked out. The values given for a speed of 60 miles per hour are 8.7 per cent. for a 25-foot span, and 3.7 and 1.7 per cent. for spans of 50 and 100 feet respectively.

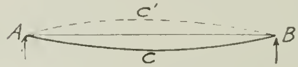


Fig. 1.—Deflection Under Moving Load

The percentages given above are relatively quite small. They are still further reduced by practical considerations, since in most cases bridge structures, when erected, are given a camber, that is, they are bowed upward, as shown by the dotted line AC'B of Fig. 1, to such an extent that under full live load the track is straight. The rolling load then moves along practically a straight line and little or no centrifugal force is set up, even at high speed.

When the impact is in the nature of a series of impulses, as in causes two to four given above, it is possible, in certain simple cases, to obtain some idea of the nature of the impact stresses. So many variables enter, however, even in a simple case, that the resulting expression is qualitative rather than quantitative in nature.

The case of unbalanced locomotive drivers is the most important of the impact-causing loads coming under this head, and the discussion will therefore refer to this cause of impact.

In order to transfer the power from the cylinders to the drive wheels of a locomotive, it is necessary to make use of a combination of rotating and reciprocating parts. It is possible to obtain a perfect balance for the rotating parts by means of properly placed counterweights. But in order to balance the reciprocating parts, it is necessary to add to the counterbalance certain weights over and above what is necessary to balance the rotating parts. This added weight is in the nature of an unbalanced force,

*Abstracted from article in the Wisconsin Engineer.

so far as the track is concerned. In most cases this added weight is about 300 pounds per axle, but may reach 900 pounds in extreme cases. Fig. 2 shows the path of such a counterweight during the forward motion of the drive wheel.

The vertical forces produced by centrifugal force, act according to the laws of simple harmonic motion. As a drive wheel 7 feet in diameter, travelling at 60 miles per hour, makes about 250 revolutions per minute, it can be seen that the vertical forces due to centrifugal effect may easily be a large percentage of the load on the driver.

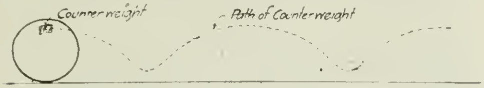


Fig. 2.—Path of the Counterweight

Such a varying force acting on a structure, first as a downward load, tending to deflect the structure downward and then as an upward force, tending to deflect the structure upward, will, if continued for any length of time, set the structure into vibration. A complete mathematical discussion of the subject will be found in Bulletin 125 of the American Railway Engineering Association, for July, 1910.

Fig. 3 shows, in a way, the sequence of events as a single unbalanced load passes over a structure at high speed. Sketch (a) shows the beam carrying the single unbalanced load. As mentioned earlier in this article, the static and impact live load effects can be considered separately and the two added to give total effect. On this assumption sketch (b) shows the static deflection of the centre point C as the load moves slowly over the span. This is called an influence line for deflection, and differs from the ordinary deflection diagram in that the deflection *d*, of sketch (b), shows the deflection of point C, sketch (a), for the load at point D. In the same way sketch (c) shows the effect of the centrifugal forces due to the rotating

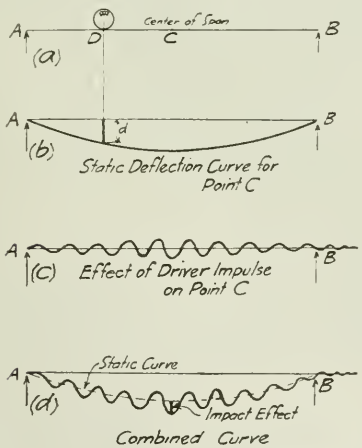


Fig. 3.—Effect of Centrifugal Force on Deflection

counterweight on the position of point C. As the load moves onto the span, the effect of the varying load is to set the beam into vibration. This vibration becomes a maximum as the load approaches the beam centre, after which it gradually dampens out. The curve is continued beyond the end of the span in order to show that the beam remains in vibration for a short time after the load has passed off the span. Finally, sketch (d) shows the combined curve.

The curves of Fig. 3 show ideal conditions, which occur when the period of rotation of the counterweights coincide with the period of vibration of the structure. Under such conditions the vibration is cumulative, and the maximum combined effect is obtained. At the centre of sketch (d) where the maximum effect is shown, the distance from the static curve, shown by dotted lines, to the combined curve, shows the effect of impact due to unbalanced drivers.

When the two periods of vibration do not coincide, the two effects may wholly or partially neutralize each other, in a manner similar to conditions studied in physics in the theory of sound waves. Where a locomotive is followed by a train load, the total weight of the train and structure is variable, as some loads pass off the span and others come onto it. This causes the period of vibration of the structure to be variable. It is then probable that the two periods coincide only for a short time. In any event, that speed of live load which produces maximum

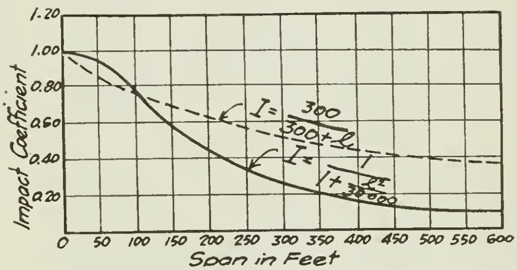


Fig. 4.—Impact Formula

cumulative vibration, and therefore maximum impact effect, is known as the critical speed.

In the theoretical discussion given in the bulletin above referred to, it has been shown that the coefficient for maximum impact which occurs at the critical speed can be expressed by the equation

$$I = k \frac{M}{p\,c\,l}$$

In this equation, I = impact coefficient; M = moment of rotation of the counterweights; p = live load per foot; c = circumference of drivers; l = span in feet; and k = a constant depending upon the design of the structure. The value of this constant must be determined by experiment. Stated in words, the equation says that the maximum impact coefficient, at critical speed, varies directly as the moment of the counterweights, and inversely as the live load, the circumference of the driver, and the span length.

The effect of eccentric wheels is somewhat similar to that of unbalanced drivers. If the speed is such that the period of rotation of the eccentric wheel coincides with the period of vibration of the structure and its load, cumulative vibrations are set up, which, in observed cases, have been equal to those produced by the locomotive.

The most important and extensive experimental attempt to determine the impact stresses in existing railway structures is that conducted by a sub-committee of the committee on Iron and Steel Structures of the American Railway Engineering Association. A complete record of the tests made will be found in the proceedings of the association (see Bulletin 125 A. R. E. A., July, 1910). The tests referred to were made under the personal direction of Dean F. E. Turneaure, of the College of Engineer-

ing of the University of Wisconsin, and the late Prof. C. L. Crandall, of Cornell University. These tests extended over a period of ten years, during which time tests were made on about 60 bridge spans which varied in length from 25 to 550 feet. In all, about 2,500 test runs were made, with test trains, and about 20,000 records were taken.

Based on a careful study of these tests, the sub-committee has proposed the following formula as representing in its judgment the probable maximum values of the impact coefficient.

$$I = \frac{1}{1 + \frac{l^2}{30,000}}$$

In this formula, l = span length in feet, and I = percentage of impact, or impact coefficient. The above equation is shown graphically in Fig. 4.

The determination of impact stresses by empirical formulas is usually based upon the personal experience of the author of the formula. A number of such formulas have been proposed. The formula which has met with the

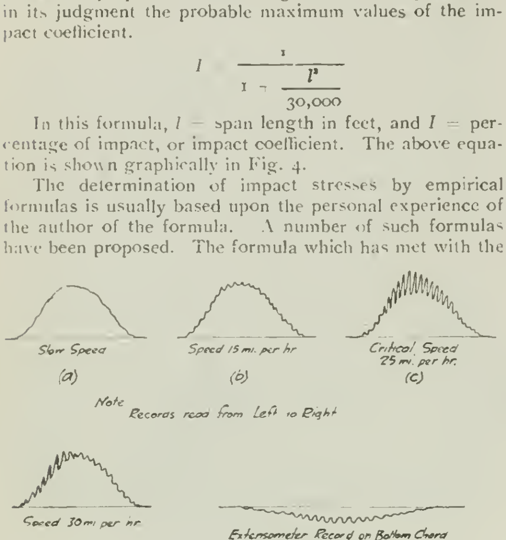


Fig. 5.—Records Taken With a Deflectometer

widest use is that given in the specifications of the American Bridge Company. This formula is

$$I = \frac{300}{300 + l}$$

The terms in this formula have the same meaning as those in the A. R. E. A. formula. It is shown in Fig. 4 plotted as a curve.

Comparing the two curves, it will be seen that the A. R. E. A. proposed formula gives much smaller values for spans over 100 feet in length. As the A. R. E. A. formula is derived from experiments, it probably more nearly represents actual conditions.

The object of the A. R. E. A. tests was the determination of the maximum impact coefficient. From the equation given for this coefficient, it can be seen that the desired coefficient depends upon the characteristics of the structure and the locomotive. The impact coefficient for a given structure may be different for two locomotives of different types, as for example, passenger engines, with large drivers, and freight engines with small drivers.

In order to determine the maximum impact coefficient by experiment, a given test train is run across the structure at varying speeds. The test is usually started with a slow run of about ten miles per hour. Due to the slow speed the rotating counterweights have practically no centrifugal effect, and the records are equivalent to static diagrams. Other runs are then made, gradually increasing the speed by small increments of about five miles per hour, until the record shows that the critical speed, and also the maximum impact, has been reached. By comparing the high speed records with the static or slow speed records, the amount of impact can be readily determined.

To illustrate the general process, the character of the records obtained during a test for maximum impact a few diagrams of actual test records are given in Fig. 5. Most of the records shown are from the deflectometer, as this shows best the action of the structure as a whole.

The records shown were taken on a 300-foot span. Sketch (a) was taken for a slow speed. The curve is fairly smooth and represents static effect. In (b) the curve becomes wavy, showing that the centrifugal effect of the counterweights is becoming evident. The maximum counterweight effect occurs in (c) for a speed of 25 miles per hour. Here the agreement between period of rotation of the drivers and the period of vibration of the structure is probably exact. It will be noted that if the static curve of (a) were sketched on the maximum combined curve of (c) it would cut an average line through the centre of the "saw teeth" of the latter curve. At a somewhat higher speed, shown in (d), the curve starts with well-defined saw teeth, but as the train advances onto the span, its period of vibration is decreased and the vibration becomes broken up, as shown by the irregular saw teeth. Sketch (e) is an extensometer record taken on the lower chord of the truss at the same time (c) was taken. Note the well-defined saw teeth on this record.

It is of interest to note that slow order sign boards at the ends of the bridge from which the records of Fig. 5 were taken called for a speed limit of 25 miles per hour. Sketch (c) shows that, for certain locomotives at least, this was the worst possible speed for the structure. In this case a speed of 40 miles per hour might have been better for the bridge than the slower speed.

Judgment has been rendered rejecting the petition of the directors of the Central Railway Company of Canada for confirmation of a scheme of arrangement between that company and its creditors. F. Stuart Williamson, M.Can.Soc.C.E., Montreal, has been appointed receiver of the company in response to the application made to that effect by the City Safe Deposit Company, of London, England, who are trustees for the bond holders.

The iron ore mined in the United States in 1917 amounted to about 75,324,000 gross tons, compared with 75,167,672 tons in 1916, an increase of 0.2 per cent. The imports of iron ore for the 11 months ending November 30th, 1917, according to the Bureau of Foreign and Domestic Commerce, Department of Commerce, amounted to 913,500 gross tons, so that probably the imports for the whole year reached 988,500 tons, compared with 1,325,736 tons in 1916.—Official Bulletin, U.S.A., Committee on Public Information.

Blasting with liquid air is said to have been rapidly developed in Germany since the beginning of the war. Holes drilled in rock are charged with five cartridges, which are simply small bags soaked in a bucket of liquid air after they have absorbed a sufficient amount of it, when they are jammed, like wet rags, into the drill hole with a stick, and fired by electricity. A single 90-grain cartridge costs approximately 6/10 as much as an equivalent dynamite cartridge. It is said to be 50 per cent. more powerful than dynamite, and the cost just about one-half as much in large quantities.

A boom derrick, used to handle spoil excavated from the lock pit of a Texas canal was rigged so that the spoil bucket handled by it could be dumped at a distance of 300 feet from the mast. This was effected by rigging a trolley line cable from the bottom of the mast to a sheave on the end of the boom, thence through the bottom block of the hoisting tackle, and to the top of the tail tower, where it was made fast. The boom was topped and the bucket hoisted, and was then allowed to move downward on the inclined trolley cable to the required point, where it was dumped and then returned for another load. It was found that for a distance of 300 feet a 12-foot drop was required, and that a load of 2,500 pounds was necessary for operation on this flat slope. In soft, wet ground a gang of seven men, including foremen and hoister, could handle 137 buckets in eight hours.

MANUFACTURE OF SEWER PIPE*

By Dr. Frank Coleman
Hamilton and Toronto Sewer Pipe Company, Limited

IN offering this association some remarks on the manufacture of sewer pipe, it is necessary to keep in mind the fact that but a few of its members are directly interested in this branch of clay working. An attempt will therefore be made to state some facts that may be of interest to all in some degree, and be sufficiently worthy of the consideration of those engaged in this business to elicit their helpful criticism.

Raw Material

In considering this question the presence of alumina and silica, the basic and essential constituents of clay substance, is assumed, and attention is turned to the other contents, which are more or less incidental but of much importance, and to the necessary qualification of a suitable material.

We in Ontario make use of a deposit, usually called medina shale. The harder and more brittle shale, which is found rather abundantly, and from which such excellent dry pressed brick is made, and the surface clays used for the manufacture of common brick, are not suited for the purpose. In a general way the suitable material may be said to occupy an intermediate position. It is more plastic than the harder shales and differs in respect to chemical composition, while at the same time possesses a stronger body and different burning qualities than the lighter surface clays.

Any material to be suitable must possess sufficient plasticity to permit of its being pressed and moulded into forms. It must be of such a nature that it will pass through the dryer without excessive warping or cracking, and finally, it must burn until a vitrified body and salt glazed surface is produced.

Experienced observers may search for and find what appears to be the required material. A thorough test is then to be made throughout the entire process, and this may verify or negative the opinion formed. A favorable result of such a test is not, however, sufficient evidence upon which to make the investment required for a plant. It may turn out that the sample (even if large, which it should be) was only a pocket.

Chemical analysis is still less dependable; such a test may indeed prove that a sample is not suitable, but by itself it can never be relied upon as a proof that it is suitable.

Lime a Source of Trouble

Among various other contents of the clay, lime may be particularly mentioned, as it proves very troublesome in this part of Ontario. It is met at every turn and at every stage of the process, and always spells "trouble." Its presence is at times fairly evident and hence more easily avoided, but at other times your first intimation is spoiled ware.

Lime occurs chiefly in one of two forms: (1) Larger or smaller pieces of carbonate of lime—these may be colored red like the shale and may be quite soft, or hard and stony; (2) carbonate of lime in a very finely divided state mixed throughout the material; and solution of salts of lime. This division is made on account of the different defects produced rather than because of chemical differences in the two classes.

The lumps may enter small enough or be ground fine enough to permit passage through the screen plates of the dry pans and not be specially or at all noticeable in the ware when pressed or while drying. When the goods are burned these pieces of carbonate of lime are converted into the oxide or quicklime. Upon removal from the kilns and exposure to rain or even to the moisture of the atmosphere, the pieces of lime become slacked. The pressure resulting from this change is sufficiently great to burst the surrounding material, and holes are produced of varying size in which is seen the lime.

Prevents Glazing Action on Tile

In the second form in which lime occurs, the trouble assumes a different character. Under these circumstances the lime is carried by the water through the pores of the ware to the surface; here evaporation takes place and the water leaves the lime behind as a whiteish more or less crystalline scum on the surface. This scum is added to as more water brings more lime to the surface during water-smoking until a more or less heavy coating results.

The sulphur fumes from the coal gas act upon this lime, producing the sulphate of lime or gypsum. This does not burn off and prevents the action of the gases on the ware. The soda of the salt used for glazing is similarly prevented from acting on the clay substance. The net result of this surface condition is grayish colored goods instead of the browns or black required, and the entire absence of glaze.

Another effect of lime to be mentioned now and referred to later is due to the fact that it is a powerful flux. The presence of any considerable quantity results in vitrification occurring earlier and more suddenly.

To overcome these effects of lime, chemicals may be used (chiefly barium carbonate) and are in some places where the percentage of lime is not too high. However, when the labor and other costs of overcoming the defects of raw material become multiplied, it becomes a question whether it would not be better to secure material from a less polluted source.

Effect of Carbon and Iron

The presence of carbon in material otherwise suitable, is perhaps, in this locality not of serious importance. It occurs chiefly in the form of larger or smaller roots, and some other vegetable substances. Much of this is to be screened out; the balance, of course, has to be burned out. The carbon present may be a cause of black coring, but this color is not simply charring—it is chiefly due to the fact that the iron present has been reduced by the carbon to the black oxide.

Of course, it is known that red shale contains iron. This important constituent is not only responsible for the color of the goods, but is also a powerful flux, safe and salutory under proper conditions, but disastrous if improperly managed.

The iron occurs chiefly in the form of ferric oxide, although some carbonate may be present, and, at times, sulphite. The latter two, however, sooner or later, lose the carbonic acid gas and sulphur respectively, and are changed into oxide. In the presence of sufficient oxygen, or under oxidizing conditions, the red ferric oxide results, under reducing conditions, in black or ferrous oxide. That there is an important difference between these two becomes apparent during burning.

Gathering and Preparing Material

The gathering of raw material offers little worthy of comment. The usual stripping to get rid of surface loam

*Paper read before the Canadian Clay Products Association, Toronto.

and vegetable materials is familiar to all, as is also the fact that a particularly strong clay may be the better for admixture with some of the lighter surface soils. Where such mixing is desirable, it is well to take together the full depth of the bank used.

At times it becomes necessary to shift or even to abandon a considerable area when the implacable lime menace is encountered. At other times a substantial bank peters out to an unprofitable shallowness.

It is fairly apparent why plants for the manufacture of sewer pipe in Ontario are centrally located and not erected upon the ground from which it is expected to secure raw materials. Insufficient quantities in a given location to last a number of years necessitates rather frequent shifting. It then becomes necessary to load material to railroad cars and to unload from same at the plant, and it then matters but little whether the haul is one mile or forty.

The preparation differs very little from that required for other clay products. The material should be ground in the dry state, usually by dry pans with screen bottoms. Further and finer screening is very desirable when possible. The material is then conveyed to hoppers, from which it is delivered by chutes to the wet pans for wet grinding or tempering. For the smaller sizes little further mixing is required, but for the larger, grog must be added to open the pores of the thicker body, that drying may be more rapid and more complete. For moulded ware more tempering and more careful selection of the material to be mixed is required.

Making the Ware

The machinery employed has not changed in essential features for many years. There is the steam press and the plaster moulds of our forefathers. Whether this fact indicated a want of inventiveness in this industry or an unusual wisdom on the part of the pioneers, must be left for others to judge.

The dies used require careful consideration, and must be adapted to the needs of the individual manufacturer and his material. Many of you are aware how great a difference a very slight change of variation in a die may make. Changes in raw material must also be met by necessary die changes. A die that will make a perfectly satisfactory pipe with some clays will not be at all suitable for others.

Drying

Drying is a very important step in the process. Just here it may not be amiss to suggest that in considering the requirements and difficulties of any part of the process of manufacture, it is necessary that all previous steps be appreciated and their influence appraised. One may say that certain defects resulted in drying. This may be true, but not be the fault of the drying process. Quite possibly that should be traced back to the raw material, or its treatment at any stage before reaching the dryer. This holds true for conditions until the pipe are entirely finished.

The floor space required for drying is rather considerable for as a rule each pipe has to stand alone. Means must be provided not only to supply the required heat and to distribute it evenly, but also to carry off the moisture-laden air.

We employ a steam heated concrete ground floor with spaced wooden upper floors, and a chamber of steam-heated pipe coils from which the warm air is distributed to all parts by means of a motor-driven fan and a system of galvanized conduits. In addition there has been recently installed overhead steam-heated pipe coils to increase the efficiency. Numerous and large ventilators in the roof provide the means for carrying off the moist air.

The temperature that the ware will stand has to be rather closely gauged at times and this may be checked by the use of recording thermometers.

Large pipe cannot be exposed, with safety, to temperatures that may cause no harm to smaller sizes. Too great a current of air, whether warm or cold, direct upon the pipe, must always be avoided.

To dry the ware as quickly as possible favors increased output and economy, but too much haste results in large wastage and defeats the object of low cost.

The pipe should remain in the dryer until bone dry, which takes from three to fourteen days, according to the size of the pipe and other conditions, such as the weather, etc. If set in the kilns in an under-dry state, some of the troubles resulting should be charged to this fact and not to the burner.

Kiln Practice

The kilns are of the usual round down-draft variety in which the pipe are set in circles. Those set nearest the bags are so arranged that they escape too direct action of the fires. The usual custom is to set several sizes in each kiln with the larger ones towards the centre, where they are placed in tiers four high. Nesting cannot be adopted to advantage, to any considerable extent, as the lessened draft between such pipe is likely to spoil both, but particularly the inside ones. In sizes of 16 inches and upwards small pipe may be set. Small pipe are also bunged in the spaces between the large ones. Traps, elbows, and other fittings are placed on top of pipe of suitable size from which they are separated by dry rings to avoid pressure effects.

The kiln floor should be as level as possible and under each bottom pipe is placed a ring of corresponding size. This helps to overcome any inequalities of the floor and permits the pipe when shrinking to creep more readily.

Burning

Burning involves four processes: (*a*) water-smoking, (*b*) dehydration and oxidation, (*c*) vitrification, (*d*) glazing.

It is our custom to commence firing immediately with coal, only sufficient wood for kindling purposes being used. The coal must be screened lump, long-flamed gas coal of good quality, and particularly, it must have a low sulphur content.

The early or water-smoking period is accomplished by firing lightly that the increase of heat may be slow and gradual.

Although appearing and feeling dry when set, there is much water in the ware to be disposed of. This water is not chemically combined, but is so closely joined to the clay substance that considerable heat is required for its removal, and it is probably not all removed until the coolest part of the kiln reaches a temperature above 400 degs. F. It is chiefly at this time that blistering and slabbing occurs, and this is usually found in the larger-sized pipe with thicker bodies.

This water must find its way from the deeper parts of the ware through the pores to the surface from which it escapes. Much of it must first be converted into steam and if steam is produced too rapidly or in too large a volume at any one time, the pores cannot contain it and internal pressure results, with separation of the laminae of the ware and swelling. Carried a little further this pressure will cause the outer layers to separate and the slabbing mentioned results. The degree of this defect

varies from blisters of different sizes to a condition in which but little of the pipe remains standing.

To determine when water-smoking is completed, the cold-rod test is frequently relied upon, but this will not show whether the danger of the period has been avoided.

Pyrometer Makes Good Guide

It is of little value to know that the water is gone if in the going the ware has been spoiled. What is needed is a means of knowing that the process is being safely conducted, and for this purpose the writer is of the opinion that the pyrometer is the best guide. By this method the temperature may be known and regulated both as to the top and the bottom of the kiln, and having ascertained a safe rate of advance, the results will be constant for fairly constant starting conditions.

The heat may now be advanced more rapidly, as but little change occurs in the ware until the stages of dehydration and oxidation are reached. This is a period during which water is again liberated from the ware, but now it is the water of crystallization or that which was chemically combined with the clay substances.

At or about the same temperature required for this result, other changes in the chemical arrangement of the clay substances also occur. The carbonate gives off carbon dioxide, the sulphides liberate sulphur and the carbon is burned out.

Having reached the important period of oxidation, care must be taken to prevent the fires from being of too reducing a character. Of course, as fuel is supplied and then gradually burns we have alternating, reducing and oxidizing conditions. Up to a certain point or temperature, such alternation does no harm, but as the stage of vitrification is approached, oxidizing conditions must be maintained.

While the ware is still porous enough to permit of free interchange of gases, the black coring of ferrous oxide may be changed almost at will, but when the ware begins to assume a close, dense character, the black that is present remains for keeps. The kiln may still be finished and saved, but at great risk, and with an inferior product. The risk lies in the fact that vitrification occurs earlier and more suddenly in the presence of the black oxide than in the presence of the red oxide. As stated, the presence of lime also tends to early and rapid vitrification.

Vitrification

As a result of increased temperatures, further changes take place with the production of a more or less glassy condition of the ware. Dehydration and subsequent oxidation cause disintegration of various ingredients of the clay substances with opening up of the body of the ware. At that time the porosity is increased and the absorption high. Vitrification causes a fusion or union. The spaces are gradually filled and the ware shrinks. The substance becomes dense and darker in color, the strength is greatly increased, and the absorption of water reduced.

Such ware will absorb but little water and will not permit its passage. It is unaffected by corroding gases, acids or alkalis, and is for these reasons a safe and sure carrier for sewage, whether sanitary or industrial.

Salt Glazing

These qualities of the ware are enhanced by the final process of salt glazing. With the kiln ready for finishing and the fires all hot, a shovel full of salt is well scattered over each. The salt is split into chlorine gas, which passes off, and free sodium which combines with the surface forming the silicate of soda glass.

The heat is maintained by adding to each fire a bundle of wood and a small amount of coal. This is repeated from three to six times, according to results obtained, as shown by trial pieces. The process may have to be shortened if the appearance of the kiln indicates that the heat cannot be safely continued.

The burning may now be said to be completed, but unless the kiln is properly managed, much damage may yet result. Everyone with experience has seen trial pieces that when taken out during the burning showed a mirror-like glaze and yet when the pipe were removed from the kiln the beauty was gone. The glaze was still there, but not the gloss. This change occurred during the cooling, and is the result of the action of the gases in the kiln and of those coming from the fire boxes.

Remove Gases from Kiln

The remedy for this is to rapidly remove the gases from the kiln and to prevent the gas from the cooling fires from entering. The former may be accomplished by freely opening the kiln, completely closing the stack opening and thus producing a strong back draft. This is perfectly safe if not too long continued. To avoid gases from the fires, the latter may be drawn.

Opinions vary as to the best methods of cooling kilns. The object, of course, is that this may be accomplished as quickly as possible and yet that air checking of the ware may be avoided. It has been advocated that the kiln openings be closed and the hot air gradually withdrawn through the flues and stack. Others claim that such a method favors air checking and recommend that the kiln be cooled without the aid of the stack draft. Our experience would suggest the latter method as being the safer one. As in other stages, time-saving must not unduly risk pipe loss, and air checked goods are of no value.

We employ as aids in the control of burning, pyrometric system, trial pieces of ware, pyrometric cones, and in addition to these such skill as the burner may possess from observation and experience.

A discussion of methods and merits of the pyrometer would be out of place at this time, but we believe it to be very helpful, particularly in the early stages of burning.

The trial pieces are a necessity. They are placed on top and bottom pipes in various parts of the kiln, within reach of hooks. From these, the condition of the ware from time to time may best be judged, and especially the important stage of oxidation.

Pyrometric cones furnish valuable information as to the period of finishing. These, like the ware, are affected both by the degree and the amount of heat and fluxing conditions.

Cement was first put on the market in England. In 1875 the use of Portland cement in the United States came into commercial prominence. When the product was first placed on the market in competition with that which was being imported from England and Germany, a good price was demanded. However, production in excess of demand soon resulted and it proved a big factor in the price cutting that followed. The second and most important reason for declining prices was due to an improvement in the methods of manufacture. From 1890 up to the present time there have been constant improvements, the use of more economical fuel, the invention of better and more efficient machinery. In a period of 15 years the cement output in the United States has increased over 600 per cent.

COST-KEEPING AND CONSTRUCTION ACCOUNTING*

By G. Ed. Ross

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IN preparing this paper, I had in mind cost-keeping on a force-account basis from the contractor's standpoint, or else from that of the State on projects being handled directly by State forces. When the contractor's force-account is kept by the State as a check on his costs, the method varies from that outlined only in a few details.

Cost-keeping should start with the first survey and be a comprehensive continuous record extending to completion of construction. Maintenance-cost records are then started and continue from year to year. Uniformity in construction accounting is possible only to the extent of adoption of a theory or principle sufficiently elastic to be adaptable to a wide range of conditions, suitable for the largest as well as the smallest job. The method of procedure is then uniform, and the data gathered will be uniform for similar conditions on the various projects, or units of projects. The divisions on the average construction job made to insure proper supervision of the forces employed are the logical units for cost records. When segregated in this manner, it matters little whether the cost of the project is a few thousand dollars or a million; the principle involved and method of securing data by units are identical.

If the division happens to be a gang of 50 men on one mile of earth excavation, accomplishment per man per day, week, or month may be compared item by item with a rival gang of 165 men on a three-mile division, or another with 200 men on a ten-station unit, all doing similar work. All the items may not necessarily be identical, if a sufficient number are similar to make possible a fair comparison of the relative degrees of efficiency. By this comparison the accomplishment per man as well as the weak points of the less efficient gangs are apparent. It will also determine to some extent whether or not large crews are handled as economically, from the standpoint of accomplishment per man, as smaller gangs. The man-day performance-test frequently results in surprises as to the real value of foremen and superintendents, as well as those in less important positions. With this definite record at hand, those who are not accomplishing an average day's work may be detected and either "speeded up" or dropped. When men are graded and rewarded by a fair test of efficiency, increased effort and results are insured.

Many of the items of cost develop with the work. Washing out false-work and piers on bridge construction, earth-slides on road construction, and similar accidents are likely to occur. For this reason, it is practically impossible to determine in advance just what form the final statement of costs will have. Considerable detail is necessary, and by keeping the data in small items during the construction period, they may be finally assembled in the desired form. As a supporting narrative for charges against the various account-numbers, and for historical purposes, the cost-keeper should keep a diary of important events during construction. Another necessary permanent record in keeping costs is a comprehensive narrative statement covering such items as wages paid the various classes of labor, cost of materials and supplies on the job, rental and purchase prices of equipment, the kind of equipment used, with information regarding the good or weak points and the methods employed to improve the service of the equipment, weather conditions, the condition of the labor market, distance from the project to the nearest shipping point, and any other data that have a direct bearing on the work performed. The value of the cost record as a basis in subsequent years for other estimates will depend largely on the fullness and accuracy of this narrative statement. Cost records of two years ago are of little value to-day as a basis for estimates without such a narrative as above outlined, because of the fluctuation in prices of material, supplies, and labor.

The time-book used in our work has spaces for account-numbers. Usually two spaces with eight sub-divisions for account-numbers are allotted each man, although as a rule he will work under only one or two account-numbers during the entire month. This record is made by the time-keeper in the field twice each day, or as many more times as the nature of the work may require. While the large number of items in the account-number book may seem confusing at first, each project (unless it be a very large one) is required to handle at the most not over thirty numbers during one month for labor costs, and a few more numbers for materials and supplies. The number is inserted in the proper place and the time-keeper is soon sufficiently familiar with them to carry them in his mind. In segregating costs an "x" or the number of hours, if less than a whole day, is placed opposite the proper number. If the timekeeper is reasonably careful, there is no excuse for error. At the close of the month, the time-book is totalled by pages and a summary by account-numbers is made. This is a good check on the accuracy of the timekeeper's work. If the gross amount in both cases by pages and by account numbers is the same, the timekeeper can feel pretty sure that he has not made any errors, provided he has counted the number of days properly. This is the one possibility of error that should have careful attention, as the remainder of the book checks itself. The invoices are received by the time-keeper, the goods checked and the bills approved, if correct. The account-numbers are then entered opposite each item and the record mailed to the general office. The items from all projects under way are then summarized in the general office and the record on the cost-ledger sheet is the result. Every feature bears its share of administrative cost. When the books are finally closed, a total of the cost-ledger features, together with the appraised value of equipment and supplies left, should balance with the gross expenditures on each project. A record of actual costs is the result of this manner of procedure.

Contractors have been known to finish a job with the firm conviction during its progress that they were making a profit. Their method of checking unit costs indicated a safe margin over the contract price, but they found on their final settlement a loss on the completed job. The overhead and incidental charges, always to be found on construction work, had been entirely overlooked. There was no check on these expenses during the progress of the the work and the revelation of the loss was a decided shock.

The numerical system of cost-keeping and accounting is adaptable to any work consisting of numerous items, departments, or divisions, on which detailed unit costs are desired. It is simple in its operation, after once the principle is thoroughly understood, and is intended to meet all emergencies that arise on construction work. Costs on divisions are assembled in such form that it may be known at all times just what units are within the estimated cost, and those running higher on which special

*Address delivered at meeting of Northwest Society of Highway Engineers.

study is required. The forms necessary in its operation are few and inexpensive. The record that is kept by the department segregates the cost-keeping record into 24 distinct "features." These "features" are then subdivided into 1,030 items. There are more items on our work than would ordinarily be used by the average contractor. On public work every one seems to feel that he has a right to ask questions and have records produced for his scrutiny. A number of people entirely unfamiliar with construction work request the department for data which could not be furnished except for the large number of items that we carry. As a matter of fact there is little more work required in gathering the original costs segregated in this way than would be needed if fewer numbers were used, and we are able, by assembling various items, to give the costs in any manner that may be desired.

At the close of the job, practically the only cost that is required is the "feature-cost" of the work. During the progress of the work, however, the items are important. These should be assembled frequently by the timekeeper for the superintendent. Daily costs are good things on a new job until the work is well under way and the superintendent is assured that his organization is keeping within or below the estimate. After that, summarizing costs for estimating purposes should be done two or three times a week so that the work cannot "get away" from him. After the timekeeper becomes familiar with this method of handling his costs, it should take him but a few minutes each evening (not over half an hour, for a crew of 250 men or less) to compute his daily costs. A wide-awake timekeeper should know the approximate cost of materials used on the work every day. He should be able to compute the labor cost and make a safe estimate as to the cost of the work done that day. This, of course, cannot be done with absolute accuracy, as it is a matter of estimation throughout. He gets his estimated yardage moved by timing the slip-scrapers, fresnos, or wheelers for a given period, knowing the capacity of each of these. He should know the exact labor-cost and the approximate material-cost. Some allowance should be made for variations. If the costs are near the estimate or above it, he should make an effort to get absolutely accurate costs and thus determine the proper procedure.

This is the real value of any cost-keeping system, namely, being able to check the costs of the work during its progress, and to give the engineer or superintendent daily costs sufficiently accurate for him to keep a close grip on that work, insuring a profit for the contractor. It is always pleasing to the clerical man to have a neat set of records at the end of a job, but contractors and contractors' employees cannot live on paper records. What they want and what they must have, if they are to continue in the business, is a sufficiently accurate check on their unit costs, while the costs are being produced, to insure their making a profit, or if they are not making a profit to be able to put their finger on the weak point in time to remedy any defect that might not have occurred to them had the fact that they were losing money remained undiscovered until the work was completed.

The cost of operation is to be considered as well as the efficiency of the system itself. A system may be thorough and accomplish everything required of it, but if its operation is too costly for the average contractor, it is in the same class as merchandise which is too expensive for the consumer. We have given careful attention to the operation of this method of gathering costs, with a view to eliminating every possible expense without impairing its general usefulness. Good forms on cost-keeping work, when carefully prepared and intelligently used, are a decided asset. As a rule, however, there is a tendency to run too much to forms, without any definite idea as to their real use and value. Frequently employees in the organization are allowed to express their spasmodic inspirations in the shape of a new cost-keeping form, although they have but little knowledge of the real requirements, except perhaps from a narrow viewpoint that they have obtained from their connection with one unit of a large project.

We use few forms. In fact, a good summary of costs can be prepared on a blank sheet of paper. This is another advantage of the numerical system of accounting, as it makes it unnecessary to carry a multitude of forms in order to summarize the data desired. We have found also that there is no good reason why the forms should be large. Our forms are practically all pocket-size to fit the books that are ordinarily carried by engineers, and we do not find that by reducing the size of the form any of its efficiency or value is lost. There are many advantages in this aside from the convenience. We find that the forms used for the collecting of cost data in the auditing department do not cost one-tenth as much as those formerly used, not to mention the far better record secured with the smaller form. The cost-ledger sheets are thin and the record is made with India ink. Blue-prints may be made any time a reproduction is desired. This ensures a reproduction of the first record without possibility of error. In the assembling of engineering data, such as monthly-estimate reports, we do require a few larger forms, but we endeavor to have these as few as possible. When a form is prepared, a careful study is made to see if with a little variation it can be made to fit several purposes just as well as the original purpose for which it was prepared.

During the few years that the State Highway Commission has been organized, there has been ample opportunity for studying the legal requirements in public records. The only record a court will consider, in case of difference of opinion between contractors and the engineer, is the original record taken in the field. While we hope there will be no more law-suits or difficulties of that nature, it is to the advantage of the department always to keep its records in such a manner as to meet the requirements of any court, and especially in view of the fact that, when this is kept in mind from the beginning, the cost of such records is not greater than the haphazard records that frequently are gathered. We have, therefore, insisted that the timekeeper carry the time-book in the field and make his original record as he goes. This soils the time-book somewhat in rainy weather, but to offset that there is much less liability of error when the time is taken in the field and kept in the permanent record, than when it is re-copied in the evening after the time-keeper has done a day's work and is tired. There is where the errors are usually made and there are plenty of other important matters on which the timekeeper can spend his time rather than to be copying and re-copying unnecessarily. These records are sent to the general office each month, carefully labelled, vouchers prepared, and originals filed away to form a part of the permanent record of the department.

Methods of accounting for field work differ materially in almost every respect from those employed in the average mercantile business. This is a fact that is frequently overlooked by accountants when preparing cost-keeping systems for construction work. In the first place, the system should not be made simply for the use of experienced accountants or office-men. The man who is the most valuable on construction work and who must do the detail work in connection with the gathering of costs is frequently a man who has had little office experience.

Our experience has been that as a rule the man with long years spent in an office does not make as good a construction accountant as the man who has had just enough office experience to be fairly familiar with the rudiments of office work. For the office man with long training at a desk where everything is brought to him, it is difficult to develop the "go-out-and-get-it" spirit that is necessary for the field accountant to have if he is to make good. The man who makes good in field accounting must be alive and alert, have plenty of initiative, a fairly well-balanced judgment, and must consider no job on the project as beneath him. The time-keeper on construction work should be a man of sufficiently broad experience to be capable of handling a large amount of detail. He should take his time twice a day or as many more times as the nature of the work justifies, and he should take it at a different hour every day. He should be acquainted with the detail plans of the engineer or superintendent. He should have a fair knowledge of grading work, and of contractors' equipment, and he should know where every piece of equipment on the job is every day. He should know what every man is doing, and he should not pester the superintendent with unnecessary questions. He should know enough about mess-operation to determine the cause when a poor meal is furnished and to correct the trouble, and he should know when an economical meal is not being served in time to correct it before the cook has run the mess too far into debt. The timekeeper should also have enough backbone to face an "ugly" cook and discharge him if he finds that cook cannot make good. The timekeeper, if he is made of the right material, should be the right-hand man of the superintendent or engineer, and at the same time the errand-boy. He should look after the camp carefully, taking measures to keep the sanitary conditions good, he should know when men are sick and see that they are properly attended. In short, the timekeeper is the handy man around the camp. If his work is efficiently handled, there will usually be a well-satisfied crew, provided the superintendent is equally efficient. If the camp conditions are poor and the mess unsatisfactory, the best of superintendents will find it difficult, if not impossible, to get results. The timekeeper should know enough about accounting to handle the details thoroughly, but more important than this is the need of being active, energetic, and of having plenty of initiative.

Handling equipment charges is sometimes a difficult problem. There are several ways in which this may be done. We have finally decided that the most satisfactory way on our work is to segregate the equipment into two classes, "heavy equipment" and "small equipment." The small equipment is charged directly to the work as it is purchased. This charge is carried under "Purchase of Equipment." A list of this equipment is kept by the timekeeper, who checks it from time to time to make sure that the equipment is still on the job. The general office, however, carries it as a charge against the work until the completion of the project, when it is gathered and stored or else shipped to another unit or project. A physical valuation is made at this time, one project being credited and the other charged with what is considered to be a fair value. Heavy equipment is listed in an equipment-record book at the time of purchase, together with fully descriptive data as to its cost and other particulars. The project on which this equipment is used stands all the ordinary repairs and replacements during its service on that work. These charges are carried under the item of "Repairs to Equipment." The last item in each feature is "Depreciation on Equipment" and this carries a charge for the use of this equipment during the period it is on the project. The depreciation charge is determined as follows:

When new equipment is purchased, the probable length of its usefulness is estimated, taking into consideration the repairs that will be made from time to time, and periods when it will be idle. On this estimated period, the proper depreciation cost per month is based. For instance, we may assume that a road-grader costing $525 will last through three seasons. It probably will be in use only nine months each season, making 27 months as the time it will be used before it is valueless. This gives a depreciation charge per month of approximately $19.50. If at the end of 27 months we found that replacements and repairs still left the grader in fairly workable condition, the equipment as a whole would be credited with its value at that time. This would probably be off-set by some other piece of equipment which we had estimated would last for a certain period and was entirely worthless before that time. At the end of each job, a physical valuation is made on the equipment. If there is any material difference between the price charged the work for the use of this equipment by monthly depreciation charges and the price that the physical valuation indicates should have been charged, an adjustment is made to correct the records.

The State Highway Commission has authorized the Department to assist any counties that might wish to improve their cost methods on road work by the installation of a simplified cost-keeping system. This is without cost to the counties. With the county work we do not endeavor to go into detail as with our own department, inasmuch as the work must be directed in most cases by the various road-masters. We have, therefore, outlined a simple method of handling the cost records by counties, consisting of one number for each "feature" without any other segregation, which gives them between 25 and 30 account-numbers to handle.

For instance, our "feature" for bridges is composed of 90 items. With the County Courts, we give the "feature" one number; that is, all work connected with bridge-building is designated by one certain number, perhaps 25. The principle of the system is retained, but it is simplified to such an extent as to remove all fear in the minds of those operating it that they are getting into a mass of "red tape." As interest grows the items are developed and enlarged along suggestions made by interested officials with special attention to the ability and capacity of the various officers through whose hands this record must pass. Before installing the system, we insisted that some one man be responsible for its operation and that this man be given access to every charge made against the work. It is preferable for bills to come through his hands before being paid, to ensure his getting all charges against a certain project. In most cases, we have taken one supervisor's district as a trial project. The practice will spread over other districts as the officials realize the value of definite records. Lane county and Wasco county have been leaders in this work. These counties have now adopted practically the entire system of the State Highway Commission on nearly as elaborate a basis as is used in the general office, and we are well pleased with the results they have obtained.

The civil engineers and land surveyors of British Columbia are applying to the legislature for incorporation under the title, Engineering and Technical Institute of British Columbia. The institute will also admit to membership architects and others engaged in purely technical occupations.

HOW TO LAY OUT AND JUSTIFY A PROGRAM FOR WAR ROADS*

By Geo. C. Diehl
County Engineer, Erie County, New York.

TO justify any construction program it is necessary to affirmatively answer the inquiry, "Will such construction help win the war?"

Road construction at this time might be divided into three classes: 1st, those which assist in the war program; 2nd, those which retard the war program; 3rd, those which do not interfere with the war program. There are so many ways in which roads are of value that in order to simplify this discussion only the viewpoint will be considered wherein highways assist the railroads. The present difficulties in railroad transportation are well understood, and the problem as it is now directly presented is that haulage over highways should release locomotives and cars and relieve congestion at terminals and freight houses.

Road advocates emphatically and enthusiastically favor construction of roads which will help win the war, and by a like token they must resolutely oppose the construction of those roads which retard the war, but also urge the construction of roads which do not interfere with the war but result in considerable economic advantage.

The roads in the first class might be sub-divided into roads which radiate from railroad shipping points and those which parallel railroad lines. As railroads are now overcrowded, radiating roads are not so urgent. The principal effort should be concentrated on roads which approximately parallel railroads. Consideration should also be given to a far greater extent to those roads which have heretofore been improved.

To illustrate what a small percentage have been used, attention might be called to the statement made by Fourth Assistant Postmaster-General Blakeslee that out of 156,000 miles of improved highways in the United States there was no mail service carried over 121,000 miles.

It is necessary to fix the approximate length of motor vehicle haul. This has been variously stated from 50 miles upwards. The daily distance for motor vehicle delivery parcel post is 135 miles, and it is likely that 150 miles daily would be a safe figure on which to base calculations. War roads, therefore, would not be continuously improved across the country, but by overlapping of zones of local service there would be improved stretches for four or five hundred miles. Of course, there might be some special roads of greater length.

There will be a sufficiently large supply of gasoline, permitting a maximum use of motor vehicles.

The elements which enter into this problem include availability of local material, time required for construction, ability to provide suitable detours, and the number of cars and locomotives which would be released. It is apparent that if two roads were of equal length and other conditions were equal that the road built of local material, without using railroad haulage, would be the most desirable. Likewise a road that could be built in the shorter time would be preferred.

In order to preserve a continuous line of traffic, it would be necessary to prepare detours to carry traffic during the construction of the war roads.

In considering the various forms of traffic, it may be assumed that through travel cannot generally be carried on the highways, and that the construction is primarily for the purpose of moving local travel. This might be divided: 1st, into passenger; 2nd, freight; 3rd, express; and 4th, mail. The possibilities of moving passengers by motor vehicles are almost unlimited, providing suitable roads are furnished, as there are in this country to-day over 4,000,000 passenger cars, and these have a greater capacity of passenger miles than all of the coaches on the steam and electric railroads combined.

The railroads can be relieved to a greater extent where the centres of population, production and distribution are close together. An examination of a railroad map of the country would show that such locations are to be found largely in the New England, Eastern and Atlantic seaboard states, and the largest expenditures for war roads would be in those sections.

Between the neighboring cities in many sections of the east it is even now possible to motorize local passenger business. This would eliminate there a very large percentage—possible 75 per cent. or more—of local passenger trains, and if through passenger trains refused to carry local passengers, a considerable percentage of through trains would be eliminated. The pleasure-seeking passenger business which is carried to the White Mountains, the Adirondacks, Atlantic City and other resorts, which even in war times are much frequented, can in a large measure be transported by motor vehicles over existing improved highways, particularly from points on main railroad trunk lines.

Local freight, especially the smaller units, would be likewise transported by motor. Local express and mail packages could be carried over the highways and all of these combined would bring great relief to the railroads. This problem is very complicated and many elements must be considered to determine which roads would give the greatest amount of railroad relief for the sum expended and the time involved. The element of time is of especial importance during war.

In passing, it is pointed out that much time is given to surveys, principally for the purpose of computing the amount of earth work. If, for the purpose of these war roads such earth work is estimated instead of accurately calculated, much time would be saved. Preliminary surveys could be simplified, particularly in districts where the roads are comparatively level, final grades being frequently established just before the time of construction.

Motor vehicle passenger cars have increased in number by leaps and bounds, already arriving at figures a few years ago thought impossible. Motor truck travel over the highways is certain to increase amazingly, particularly at the close of the war, when business will expand to the maximum and the steam railroads will carry an ever-increasing tonnage. In spite of this fact it will not be surprising if an even greater tonnage is carried by motor trucks over the highways than is transported over the railroads.

It is important also to consider the width of the highways, as with the ever-increasing traffic, widths heretofore adopted will prove inadequate. To illustrate this by a concrete example: If we assume an improved 16-foot highway, generally considered a double road, and operate 3-ton motor trucks at a speed of 15 miles an hour, or a half-minute headway, that is, about 600 feet apart, 120 trucks or 360 tons could be transported in either direction every hour. In a 10-hour day, 3,600 tons in one direction, or 7,200 tons if fully loaded in both directions, could be conveyed. This would mean only the amount carried by one or two modern freight trains. Thus it will be seen when the tonnage exceeds this, unless there is operation by

*Abstracted from paper read before the Convention of American Road Builders' Association.

night and day, that the roads must be wider than 16 feet. If passenger traffic is carried over the roads, they must be much wider.

To intelligently design highways and bridges, maximum loadings must be adopted. The railroads of the country have been reconstructed several times by reason of increasing weight of rolling stock. To design a railroad bridge it is necessary to have not only the maximum load, but the wheel concentrations and distance between such concentrations. A similar plan should be adopted in highway construction. Motor vehicle manufacturers could construct cars consistent with such loading.

Political sub-divisions would be warranted in forbidding travel over highways and bridges which would not conform to the rules laid down. There must not only be a maximum weight allowed for each tire, but there must be a maximum per wheel and space between wheels. On this plan it would make no difference whether a 3-ton, 5-ton or 10-ton load were carried, as the maximum strain on roadway, bridges or other structures would he fixed.

The cost of highway construction bears a definite relation to tonnage. Assuming that the enormous contemplated increase occurs, then the public must be prepared for highway expenditures far in excess of the amounts heretofore appropriated, particularly with reference to main trunk lines, as the lateral roads can economically be constructed of the less expensive types.

Economic theories of railroad construction have been developed so that it is possible for the railroads to determine the exact expenditure which would be justified to eliminate a foot of rise and fall or a degree of curvature, and if the highways are to carry the enormous motor vehicle travel which is anticipated, then similar economic theories should be developed for highways. To illustrate, on a highway which carries 2,000 3-ton trucks daily, at a rate of 6 cents a ton-mile, the cost of haulage would amount to $360 for each mile per day. If the highway were lengthened one mile, the increased cost would amount to upwards of $125,000 a year, which, capitalized at 8 per cent., which might be a reasonable allowance for sinking fund and interest charges, would justify an expenditure of one and one-half million dollars.

Before fixing a maximum grade, it would be necessary to determine whether trailers were to be used, and if so, the total weight of the trailers and load as compared with the hauling engine. On the railroads, grades are frequently reduced to six inches to the one hundred feet, while on the highway 6 per cent. and upwards is not found objectionable when properly improved, the difference being that the locomotive forms but a small percentage of the entire weight hauled, which is not the case at present with motor vehicles. The advantage, of course, rests with the motor vehicle travel, as great distances are saved thereby. As an illustration, the distance from Albany, N.Y., to Pittsfield, Mass., is 50 miles by rail and but 38 miles by highway.

Every highway department should have a traffic engineer, as the problems of traffic are so intimately connected with construction and maintenance that the problems must be worked out jointly. The traffic department should take a frequent traffic census, as a controlling factor in many cases will be the cost of moving a ton a mile, and in order to determine this accurately, data must be kept, which will be invaluable after a period of a year or two. After a period of 8 or 10 years, it would be indispensable.

Charts can be prepared showing the relation and classes of traffic in proportion to population and amounts of production. The curves on charts prepared in states where improved highways are most prevalent would indicate to a considerable extent the type of construction, width, grades, alignment, etc.

With such a highway program there would be greatly stimulated the amount of production and territory not now available for agriculture would be opened up and the economic conditions bettered along many lines.

ROAD DRAINAGE*

By J. L. Harrison

THAT water, in one way or another, is the cause of an enormous amount of damage to highways is too generally admitted to necessitate any presentation of facts to justify a statement that the problems which arise in dealing with it are among the most serious, and at the same time among the most obscure with which the highway engineer must deal.

These problems are usually grouped under the heading "Road Drainage," and discussions of them are very likely to be limited to the presentation of generalizations in regard to the simpler aspects of the problem of freeing the right-of-way of what is obviously surplus water. However, the obvious is not always the most important, and so it happens that though of no less importance than formerly, the consideration of the problem of dealing with surface water may properly give place to the consideration of the more illusive as well as the more important problem of dealing with wet subgrades.

Thus, as this paper is presented for the consideration of gentlemen who have a considerable knowledge of highway problems, there is no need to amplify or to discuss such trite statements as that road ditches should be large enough to carry off the surface water or that they should always be kept open, etc. Neither is it necessary to caution the gentlemen here present that openings should be kept clear and that all structures should be frequently inspected, in order to preserve the proper freedom of surface flow and prevent the damage which is sure to follow when obstructions force flowing water to find and to enlarge new paths. These are matters of such common knowledge that they may be dismissed with the observation that all carefully supervised highway organizations now give them constant consideration.

When, however, the problem becomes one of dealing with sub-surface rather than with surface water, the question is obscured and the phenomena concerned are correspondingly less understood. However, it is here that the surprises are found and that the field for study and for improvement in highway design is almost untouched.

As a clear understanding of the facts is essential to a proper appreciation both of the problems which must be met and of any progress toward their solution, it may be well to note that, except perhaps in the most extreme desert regions, the sub-strata are saturated at no great depth below the surface of the ground. The level of complete saturation is known as the water table and will be found to occur at from somewhat above the surface where there are lakes, and swamps which become lakes during wet seasons, to considerable distances below the surface as in the arid regions where the water table may be many feet below the surface, if not absent entirely.

Next in importance to the fact that the water table is usually near to the surface is the fact that the water table

*Abstracted from paper read before the Indiana Road School

moves up and down with the seasons. Heavy rainfall causes the accumulation of water in the ground with a consequent elevation of the water table, and long periods of drought lower the water table both because there is a gradual sub-surface drift of the ground water from the upper elevations toward the sea, and because capillary attraction is constantly raising water from the saturated subsoil to the surface where it is carried away by evaporation. Of necessity, if the total of the loss by sub-surface movement and by evaporation exceeds the supply, the water table will be lowered. Such a condition now prevails in some sections of Nebraska where the soil survey records show that the moisture content of the soil is at the lowest point ever recorded. This is a case of a gradual lowering of the water table over a period of some years. The condition more often met with by highway engineers, and of more importance in highway design, is the relatively wide seasonal variation in the elevation of the water table, a variation which may have a range of a good many feet and which, in extreme cases, may convert areas that are dry and solid during the drier months, into almost impassable marshes during the periods when the rainfall is heavy.

The level of the water table at any given point may be raised either by the absorption of local rainfall or by an increase in the rate of the drift of the ground water which has been caused by heavy rainfall in other regions. To illustrate this point one has only to refer to so common a phenomenon as the flooding of cellars, a most annoying matter which almost every careful observer has had occasion to deal with when the local rainfall by no means justified the pronounced rise in the elevation of the water table which has brought it a foot or two above the cellar floor.

The simple raising of the water table often causes highway troubles. "Keep the subgrade dry," is an old-time admonition which was frankly based on the assumption that a good highway surface would "shed water like a roof." The dry subgrade is as much to be desired as ever, but no matter how well the "roof" acts, the subgrade will not remain dry unless water can be kept from rising into it from below. Herein lies much of the trouble which highway engineers experience in preserving smooth pavement surfaces during the spring months. At this season more moisture is supplied than evaporates or is carried off in the ground water drifts. As a result, the water table often rises to such an extent that in low areas lakes are formed, and if a highway chances to be built over an area where this rise in the water table has brought the pavement foundation into the region of complete saturation, a marked lessening of the supporting power of the foundation necessarily results.

Tile drainage is the usually accepted remedy for this condition of affairs, but tile drains have, very generally, proved to be of less usefulness than had been expected. One reason for this is that the water table does not have to rise into the foundation of a road to make it the source of trouble. All that is necessary is that it rise enough so that capillary attraction can keep the foundation wet. Just how near to the surface this may be has not yet been determined, but as extensive studies of the effect of capillary attraction in raising the water needed to support plant life, show that capillary attraction will raise water through some soils as much as six feet or more, the problem of escaping the results of capillary attraction at once appears to be a serious one. And herein lies the trouble with many of the systems of tile drainage which have been installed. Tile drains lower the water table; that is, the level of complete saturation, but they do not affect the action of capillary attraction. As such drains are seldom placed more than three or four feet below the surface, they do not at all prevent the wetting of the subgrade, for in almost all soils capillary attraction will raise enough water to keep a subgrade wet at even greater distances than this above the water table. This difficulty with tile drainage systems is entirely aside from positive errors of installation, such as the use of tiles of too short a diameter, the use of tiles without bells, the use of gradients which are too light, etc., and is an elemental difficulty which, in our present knowledge of this subject, must be admitted as existing, but which is as yet unsolved.

As illustrating to what an extent capillary attraction may affect the moisture content in the soil under a pavement, it will be interesting to many to know that one sample of soil taken just below a pavement in the business section of Washington, D.C., an asphalt pavement on a heavy concrete base, showed 12.23 per cent. of moisture by weight, which is approximately 32 per cent. by volume. The cut which had been made in the street where this sample was taken, was about ten feet deep but had not yet reached a level at which free water collected in the trench. In view of the nature of this pavement and of the fact that all of the ground for considerable distances in all directions from the point where this sample was taken is covered either by buildings or by sidewalks and pavements, it must be assumed that whatever water was found in the soil under it had come to that level by being raised from below. Here is a case, therefore, where capillary attraction had raised water enough to practically saturate a pavement foundation which is at least ten feet above the water table. In this particular case the soil under the pavement is clay. In its nearly saturated condition this clay is as plastic as good putty. Just what loads it will support has not been determined, but that if the water content in it could be reduced, its carrying capacity would be materially increased, can hardly be doubted. This case has been cited because it shows very clearly the range over which capillary attraction may act, and the amount of moisture which may be involved. It is not, however, an isolated case for the writer has found a good many pavement footings which contained even more moisture than this.

As has been pointed out, tile drainage does not solve this problem. Tile drainage will remove any water subject to the action of gravity, but in heavy clay soils the percentage of water so affected is so small that the actual level of complete saturation—the water table—is often hard to determine. The converse of this fact is that in heavy soils the percentage of water which may be raised by capillary attraction is very high and the distance through which the water may be raised is correspondingly great. Where the soil is subject to the direct action of the sun and the wind, the moisture raised by capillary attraction is evaporated and so the large amount raised each season and dissipated through evaporation is unnoticed, but where the surface is covered by an impervious layer, as by a hard pavement or even by a board, the constantly rising moisture fails to escape as it does in the open country. In fact, examinations of the water content in the soil under numerous hard pavements show that even when the soil in the surrounding fields is so dry that plant life has withered, 30 to 40 per cent. (by volume) of water may be found in the soil immediately under the pavement. This would seem to make it clear that a pavement may so shield the subgrade that a high water content is preserved even during the drier months, so high a moisture content, in fact, that it would seem fair to conclude that the much-

talked-of "dry subgrade" is, for ordinarily humid regions, purely a myth.

The significance of this condition of the subgrade composed of heavy material, even at elevations of ten feet or more above underlying water tables, is far-reaching. In the first place, it suggests a lower carrying capacity for subgrades than is usually assumed. But more in line with the subject matter of this discussion, it suggests a very cogent reason why so-called "well-drained, dry" subgrades freeze during cold weather, namely, that they are neither "well-drained" nor "dry." It may be, in fact it often is, true that they are "drained" in the approved fashion, but that they are "dry" is to be doubted, both from the fact that repeated examinations show that the soil under the pavements in the eastern half of the United States are almost never "dry," no matter how well they have been "drained" and because, had they been dry, they most certainly could not have frozen.

As affecting hard surface roads, another matter of drainage deserves consideration, namely, the relation of water in the subgrade to the cracking of these pavements. It has been shown that capillary attraction supplies so much moisture that the soils under hard surface pavements are seldom dry. During cold weather the moisture in the soil freezes, solidifying the ground into a block often a number of feet thick. This process proceeds under a pavement just as it does in other places. However, this freezing causes little or no trouble. In fact it is practically the uniform statement of engineers familiar with this matter that hard pavements go through the early winter without trouble. This is due to the fact that the freezing proceeds from the top downward and that the underlying soft earth takes up all of the expansion caused by the freezing.

As the winter proceeds, the surface of the ground now being a layer of icebound soil, winter thaws occur which melt the snow that is on the ground and perhaps also a few inches of the soil. When this occurs a wholly different problem in road drainage is presented, for the water which is taken up by the melted soil on the surface cannot percolate into the lower strata because of the intervening layer of frozen ground. Under these conditions it may, and in fact often does, happen that the top of the ground becomes completely saturated. The pavement, of course, protects the subgrade from the direct admission of water at such times as this, but this is by no means an adequate protection, not to mention a complete protection, for the complete saturation of the surface of the ground really amounts to nothing less than raising the water table to this level. Under such conditions, if the subgrade is level with or cut below the surrounding country, there is a distinct tendency for the plans of complete saturation to work its way under a pavement just as it does, for instance, under a house when the cellar fills with water from below. More or less of the water in the soil at such times is in excess of what could be retained there by capillary attraction and so is subject to comparatively rapid influence by the forces of gravity. Hence the distinct tendency of this surplus water to move rapidly into such places as the soil in a pavement footing, in response to the general principle that water will seek a level.

Even when the pavement rests on an embankment it is subject to immediate effect under such conditions as this. As stated before, the saturation of the surface of the ground, under conditions which prevent the percolation of surface water into the lower strata is, for all practical purposes, equivalent to the elevation of the water table to the level of the surface of the ground. Repeated experiments made by those who are investigating the movement of soil moisture as affecting plant life, have shown that the rate of movement by capillary attraction may be very high where the lift is short. Under the conditions here assumed, therefore,—that is, comparatively low embankments have been constructed over flat lands,—the saturation of the top soil on the flat land will produce a condition almost exactly equivalent to that which would be produced if this land were actually flooded with water, and the effect on all of the subgrade which is thawed out, even if only a few inches of the surface and a few inches under the pavement have been thawed out will, for all practical purposes, be the same. This is because capillary attraction will raise water even in a comparatively thin layer of thawed-out soil covering the surface of an embankment, just as water is raised by a wick, and will distribute it horizontally through the shoulders and under the pavement within the space of a very few days or, if the shoulders and slopes are already wet, even within a few hours. Of course, the rapidity with which a subgrade is wetted in this way depends both on its height and on the material of which it is composed, but as the subgrades usually used in highway construction are comparatively low, they are almost always within the range of capillary action.

In passing, it might be noted that the major reason for objecting to free running water in ditches, and to standing water on or near the right-of-way, is based on this same general fact, namely, that capillary attraction will very promptly bring this water into the subgrade, where it acts to lessen the supporting power of the ground on which the pavement rests.

As for hard-surface pavements, much breaking is, no doubt, due to positive overload during periods when these conditions have rendered the subgrades so wet as to be abnormally plastic, and consequently of low supporting power. The major part of the breaking of these pavements is, however, due to re-freezing after the conditions above discussed have practically saturated any thawed-out portion of the subgrade. When the re-freeze comes, conditions are different from those which prevailed at the time of the year when the subgrade was first frozen in this one particular, namely, that now the water which freezes is contained in a space between the pavement and the still un-thawed portion of the originally frozen ground mass. It is not necessary to go into a long discussion of the phenomena of freezing. Suffice it to say that in freezing, the water caught between the pavement and the frozen ground exerts a tremendous positive force which is ample not only to crack heavy pavements but to lift them considerably out of line. Moreover, the force developed in freezing is not usually relieved by a uniform movement in the overlying slab. If it was so relieved, all of a pavement block would be moved a small fraction of an inch and no great harm would be done. This does sometimes happen, but if it chances that conditions in the pavement initiate failure at some one point all of the pressure is relieved at this point, in which case the distortion at this point may be considerable. This is very similar to the process by which a boiler explodes. As long as the boiler holds, the pressure is equal on all parts of the interior. But when the stray bolts fail the front plate may be blown clear out of the building. This, by the way, explains why one corner, or one edge, or one end, etc., of a pavement block may be raised a number of inches when the total expansion due to the freezing of a good many feet of water would not equal this amount. Of course, relief has occurred at a point rather than by a general elevation of the block and the excessive distortion is the result.

For the relief of this general condition the writer recommends the use of broken stone or Telford bases, unfilled with fine material and consequently containing voids

so large that capillary action will not fill them with water. These footings should be deep enough to extend below the reach of late winter and early spring thaws and should be so drained to the ditches that no ordinary percolation, no matter from whatever source, can fill them with water. Such a system will be expensive, but it can hardly be doubted that it will be valuable enough in protecting pavements during spring weather to more than justify the necessary expense of its installation.

In closing, it is desired to point out that the careful consideration of the actual condition of pavement subgrades is becoming of more and more importance. Loadings are increasing rapidly and the highway engineer must either provide for these heavier loadings or definitely prove that they are not economically feasible. To do either, he must be able to tell pretty definitely what his subgrades can be depended on to carry, and in order to arrive at this fact he must know how his footings are going to be affected both by the water which falls on the right-of-way and by that which comes to it in other ways. The notes which have been here presented outline the problem. They do not solve it. However, they are presented with the feeling that the longest step toward the solution of a problem has been taken when the problem itself is clearly stated. The solution will come in time, but pending the solution it will be well to act on the assumption that the greatest problems in land drainage lie under the ground and are often most a factor where their presence has at first been least suspected.

MONTREAL BRANCH, CAN.SOC.C.E.

Upon formal application of sixteen Montreal members of the Canadian Society of Civil Engineers, the council of that society has authorized the formation of a Montreal Branch along the lines indicated by the new by-laws recently adopted.

The first meeting of the branch was held in the society's rooms last Thursday evening, when it was decided that a nominating committee be appointed to select at least two candidates for each of the branch offices. There will be a chairman, vice-chairman, secretary-treasurer and six committeemen. The committeemen are to be elected for two years, the others for one year. In the first election, the three committeemen receiving the largest number of votes are to remain in office for two years and the other three are to retire at the end of one year, and thereafter three committeemen are to be elected each year for a two-year term.

The nominating committee are to add to their list of nominees for any office, the names of any candidates submitted in writing by at least five corporate members. The nominations are to be made before February 28th, when letter ballots will be sent to all corporate members resident within twenty-five miles of headquarters, the ballots to be returned by March 14th. The result of the election will be announced at a meeting to be held that evening.

The members of the nominating committee are R. M. Hannaford, Frederick B. Brown, L. G. Papineau, J. Duchastel, W. Chase Thomson, M. Brodie Atkinson and H. G. Hunter.

The Vancouver Island Pile Driving Co. has just finished making extensive repairs to the wharf of the Canadian Kelp Products, Ltd., at Sidney, subsequently proceeding to the railway company's wharf which they repaired. They are now at James Island putting in a new float for the wharf there. Their next work will be at the Quarantine Station.

THE FUELS AND WATERPOWERS OF CANADA
A CONSIDERATION OF THEIR PROPER SPHERES OF USEFULNESS

By A. S. L. Barnes, A.M.I.E.E.

ALTHOUGH a considerable number of technical men have taken this matter seriously for some years now, popular opinion is very hard to influence, unless some very abnormal conditions arise which draw everyone's attention to them; in other words, there is a tremendous amount of inertia in the said "opinion." This mental inertia, like its physical counterpart, absorbs a great deal of energy before any results, in the form of motion, or action, are manifested, and as a rule the losses are great, for, usually, the larger portion of this absorbed energy is dissipated in the form of heat (-ed debate) instead of appearing in the form of useful work as it would if the mental machinery of the public (taken en masse) were reasonably efficient.

In regard to the fuel question, the abnormal circumstances referred to above are certainly with us now, and people generally are in the mood to take some notice of the warnings and advice to which technical men everywhere are giving expression.

The Commission of Conservation, the Bureau of Mines, the universities, and other bodies have been recently giving publicity to the need for thorough investigation of the whole problem.

It is for the public to take heed and see to it that the governments, Dominion and Provincial alike, are vested with full powers to take such action as, based on the best available advice, seems to be necessary.

Development work, in endeavoring to get the greatest amount of energy out of all classes of fuel, together with all possible by-products, is not only warranted by what is being done in England, Germany (especially the latter) and other countries, but is essential to Canada, and of paramount importance to the Province of Ontario on account of the peculiar and unenviable position which this province occupies in respect of coal resources.

There will be a tendency, as a daily paper recently stated, for the public to forget all about its coal troubles of the present time as soon as the warm weather comes. This will be especially true probably this year when everybody's thoughts will be focussed on food production, but the technical men who know the gravity of the situation must lead the people in this matter, for no one else is in a position to do so. Lawyers, politicians, doctors, schoolmasters, financial men and others may know that there is a difficulty ahead, but who can give the right guidance except the engineers and chemists? Without their expert knowledge millions of money might be spent, all to no purpose.

Dr. Haanel, director of the Bureau of Mines, recently stated, in referring to the utilization of peat, that it is essential, in order to prevent the waste of capital inevitably connected with misdirected effort, to employ only men with proper technical training for such work, or words to that effect, in order that the many mistakes made in the past by persons lacking such training, may be avoided.

There are two main uses to which fuels may be put:—

(1) For the generation of mechanical power.

(2) For the production of heat, to be used as such.

In some instances, in fact many, the use of fuels for the first-named purpose is unavoidable because power is needed and there is no other source available. This is the case in all localities lacking water power and at sea.

The primary object of this article is to lay down two principles which seem to the writer to be fundamental and to form the true basis of the proper conservation and use of two great natural resources of Canada, *viz.*, fuels and water power.

These principles are as follow:—

(*a*) All fuel should, as far as possible, be utilized solely for the direct production of heat, to be used as such, and not for the generation of mechanical power.

(*b*) All water power should, as far as possible, be used for the generation of mechanical power, either directly or through the medium of electricity; and all electric energy generated therefrom should also, except for special processes such as welding, electric furnace work, cooking, etc., be so utilized.

Dealing with the first of these principles, and keeping in mind the fact that the utilization of fuel for the generation of mechanical power cannot be altogether avoided, it is, nevertheless, true that such a use is wasteful and always will be so, as compared with employing it for heating purposes.

The correctness of this statement is not altered, even if all possible by-products be extracted from fuel before it is made use of as a fuel.

Take, for example, coal. It may be fired directly into boiler furnaces, which every man with technical knowledge is ready to admit is an extremely wasteful way in which to use it, or, after having had taken from it all of the many by-products which it is capable of yielding, the residual coke may be fired under the boilers, but in either case, what is the result?

Probably in a good sized modern generating station the result will be about as shown below:—

Energy in coal or coke	100%
Energy lost in boilers	25
Theoretical loss in converting energy in steam to mechanical energy in the turbine, about	52
Other losses, up to the switchboard	10
Total losses	87%
Actual energy utilized (= per cent. efficiency)	13%
Total energy as above	100%

The very largest stations, with a good load factor approaching 50%, may improve on this 13% efficiency by a matter of 2 or 3 per cent. perhaps, but not more.

If gas be obtained from the coal and used in a gas engine, a somewhat higher efficiency will be obtained, but at the best it could hardly exceed 25% and the same is true of oil or any other fuel when used for the generation of mechanical power.

Where no other source of power is available there is, of course, nothing to do but make the best of it by gaining every possible advantage in manufacturing by-products and by utilizing the most efficient plant. If, however, we turn to the use of fuel for heating, it is found that an ordinary house furnace will show an efficiency, even in the hands of the average householder, of twice, or even three or more times, that of the most up-to-date and largest electric generating stations handled by the best experts.

Technical Paper No. 97, of the U.S. Bureau of Mines, gives records of tests made by a university professor during the winter 1912-13, in his own house, he himself and his family being the only ones attending to the furnace, which show an average efficiency for the whole season of 65%. Careful records were kept of all the essential factors and there is no reason to doubt the reliability of the figures.

The foregoing sets forth the reasons why fuel should not be used for the generation of mechanical power if it can be avoided, since the quantity of fuel which will generate one horse-power of mechanical energy can easily be made to yield at least double or treble as much energy for heating purposes.

The fuel administrator of the United States, Dr. H. A. Garfield, where the use of coal for mechanical power purposes is unavoidable to a great extent, is anxious that all the energy in the coal that can possibly be made use of should be utilized, as the following extract from the "Electrical World" of January 8th, 1918, shows, and if it be right to conserve fuel in this manner, it is right to try to conserve it to a still greater extent by substituting the energy of water power.

Dr. Garfield says: "The coal consumption in the large electric plants, per kilowatt hour, is less than half that of the average small plant of less than 500 kw. rating.

"Everything possible, therefore, should be done by the large stations to cause the voluntary closing of the small isolated plant.

"The way to do this is to reduce the charges for power service as far as a reasonable return on the invested capital will permit. A general overhauling of prices charged for energy should be made, reducing the figures for power to encourage the abandonment of the small isolated plant, saving half the coal used by the latter, and recouping the loss of revenue by raising the figures for light, thus encouraging customers to be less wasteful in its use.

"It is a recognized fact that there is an enormous waste of coal due to the extravagant and luxurious use of electric light."

Taking up the second of the principles enumerated above as fundamental, *viz.*, that water powers should be utilized as far as possible for the generation of mechanical power and not for the production of heat, consideration of this matter shows that there are two excellent reasons why this should be done.

In the first place, think of the cost of electric energy throughout, say, the Province of Ontario, as compared with that of energy in coal.

Anthracite at $10 per ton, having a calorific value which may be assumed as 14,000 B.t.u. per lb., costs one-half cent per lb., or one cent will purchase 28,000 B.t.u.

In an ordinary house furnace, if 50% efficiency be obtained, as it can readily be, then 14,000 B.t.u. cost one cent, but where can electricity be purchased at such a rate, seeing that one kilowatt hour is only equal to 3,412 B.t.u. For domestic use, one cent per kw.h. is a cheap rate, yet at this price, assuming 100% efficiency for electric heating, electric energy is more than four times as expensive. From this it is evident that electricity is not at present a serious competitor of coal for heating and possibly never will be, because, supposing the price were reduced until it could compete with that of coal at $10 per ton, the coal would probably come down in price leaving electricity stranded high and dry until some further considerable reduction could be made; even if the price of coal were not lowered materially, improved methods of using it would be developed which would still enable it to leave electricity behind in the race.

The foregoing must not be taken as arguments against the use of electric energy as an auxiliary heating agent to supplement coal, oil or gas heating. For warming up a rather cold room in severe weather, which cannot otherwise be easily kept at a reasonable temperature, and for use at the beginning and end of the cold season, electric

heaters have a wide field of usefulness which ought not to be denied them.

Also, it may be remarked that in order that electric energy might become a competitor of coal for heating the actual cost would not need to be brought to an equality with that of coal as the cleanliness, convenience and elimination of disagreeable work which would accompany the adoption of electric energy would be considered by most people as well worth paying a little extra for. Further, it is conceivable that if ashes and their removal were eliminated from the expenses of a city some reduction in the rates would be possible which would be a gain in favor of electricity.

In the second place, it is necessary to consider the quantity of energy required for heating houses, etc., on a large scale.

Assume, for example, that an eight-roomed house requires 9 tons of anthracite during the winter season of $6 \times 30 = 180$ days. The average rate of coal consumption will be $\frac{9 \times 2{,}000}{180} = 100$ lbs. per day.

This is equivalent to $\frac{100 \times 14{,}000}{3{,}412} = 410$ kilowatt hours, which means an average load of $\frac{410}{24} = 17$ kilowatts (= 23 h.p.).

As, however, the furnace efficiency is only, say, 50% and the efficiency of electric heating is 100%, then the electric equivalent of the coal will be one-half of the foregoing or 8.5 kilowatts.

The load factor of the furnace, *i.e.*, the ratio of the average load to the maximum load, will be about 66% (this figure is borne out by the U.S. Bureau of Mines Bulletin already quoted), hence the equivalent maximum electrical load will be $\frac{8.5 \times 100}{66} = 13$ kilowatts. A generating station supplying electricity for heating would, therefore, have to be prepared to handle a 13-kw. load, approximately, as an average, for every house served. According to the 1911 census there were rather more than two and a half million people in Ontario at that time, time which means, probably, 500,000 homes.

If an average maximum load of only 12 kw. had to be supplied to all these homes it would account for a maximum load of 6,000,000 kw. (= 7,440,000 h.p.). Seeing that the total possible development of Ontario water powers has been estimated at under 6,000,000 horsepower, where is the power to come from to furnish even a considerable proportion of the homes of Ontario (exclusive of the requirements of factories, office buildings, etc.) with electric energy for heating, quite apart from the great requirements for power, lighting, electric traction, etc.?

This second consideration, aside altogether from questions of cost, should effectually dispose of the popular notion which has been growing a good deal within the past few years, and has even been fostered in some quarters by those who might have known better had they taken the trouble to make a few simple calculations, that electricity is destined to become a great, in fact *the* great, agent for heating.

True conservation, therefore, lies in utilizing the water powers of the country to the fullest practicable extent for mechanical power for factories, railways, metallurgical and other purposes for which they are specially adapted, through the medium of electric energy, and in using the fuels, in the most economical manner possible for heating and *not* for the generation of mechanical power.

As showing whether, from the standpoint of conservation, it would be wise to operate railways by electric power instead of with coal or other fuel, it may be stated that figures, which appeared in the Electric Railway Journal last year for one of the United States lines are as follows:

Freight service—
39.4 kw.h. per 1,000 ton-miles.
276 lbs. coal per 1,000 ton-miles.

Passenger service—
29.1 kw.h. per train mile.
188 lbs. coal per train mile.

Assuming the use of coal having a calorific value of 12,000 B.t.u. per lb., the foregoing figures mean that the efficiency of conversion of the energy in the coal to mechanical power on the rails is, for the two services, 4% and 4.6% respectively, or an average of 4.3%.

Were the railways of Canada to be operated by electricity the 9,000,000 tons of coal used annually by them could be released for the production of heat at an efficiency of 50% or more instead of being used for power at less than one-tenth of that figure.

Nine million tons of coal could heat about 1,000,000 homes per season. Similarly, if it were possible to use the 10,000,000 or so tons of coal at present employed annually in the production of mechanical power another million homes could be kept warm and, as there were only, according to the 1911 census, about 1½ million occupied dwellings in the country at that time, there would be enough coal left over to heat a goodly number of business and manufacturing establishments as well.

Returning to the railway problem, if the consumption of coal on the various lines be 9,000,000 tons per annum, then, assuming an efficiency of 5%, this means (with 12,000 B.t.u. coal) an average load of about 1,600,000 kw. and possibly, owing to load factor, a maximum of three times this figure. This is easily within the capacity of Canada's available water powers, even allowing for other requirements on a large scale.

Assumptions of this kind are, of course, not capable of being acted on in their entirety for many reasons, but the relations between the figures given hold good for isolated cases equally as for the country considered as a whole.

The preceding assumptions, arguments and deductions take no notice of the financial aspect of the problems considered; they are concerned only with the question of the truest economy—that of making the country's resources last as long as possible.

Also, no consideration has been given to the use of exhaust steam for heating, which modifies the situation to some extent in many cases, but only has effect during winter, except where such steam is used in the manufacturing processes being carried out.

Among the Canadian patents recently issued through the agency of Ridout & Maybee, Toronto, are prevention of pitting and corrosion in steam boilers, Charles Haythorpe; dust and waterproof floors, Lewis S. Yolles; key bolts, Universal Tool Steel Company, Limited; internal combustion engine, Harry C. W. Neighbour; sections for sectional boilers, Anders B. Reck.

A summary of the Quebec Bill to protect public buildings in the province against fire may interest electrical engineers. The bill provides that no electric installation in a public building in the province, for the transmission of light, motive power, or heat, shall be put in or altered except by a person or under the immediate supervision of a person duly authorized and holding a license to that effect. The word "public building" in this Statute has a far-reaching effect, extending from churches and court-houses, etc.

SHIPBUILDING ON VANCOUVER ISLAND

These and other interesting facts are recited in the annual report of the Inner Harbor Association, Victoria, B.C., just published:—

When the great need for ships became apparent the Cameron Lumber Company, Limited, operating a saw mill on the Upper Harbor of Victoria, and the Genoa Bay Lumber Company, operating a mill on Cowichan Bay, Vancouver Island, organized a shipbuilding company under the title of Cameron-Genoa Mills Shipbuilders, Limited, and established a shipyard on the western shore of the Inner Harbor of the city of Victoria. Work was started thereon about the first of June, 1916. After the necessary buildings had been erected and the machinery installed, the keels for three ships were laid down in rapid succession, and work thereon pushed with all possible speed. The first ship was launched about February 1st, 1917. So far there have been launched by that company six five-masted wooden schooners. These ships are 256 feet long over all, 43 feet breadth of beam and 21 feet depth of hold, with a carrying capacity of from 1,500,000 to 1,750,000 feet of lumber, or 2,500 tons dead weight, equipped with auxiliary power of the Bolinder type of engine, developing 350 horse-power, with a normal speed of 7 knots when engine-driven, using oil fuel, and carrying a crew of 15 men.

They have proved themselves to be excellent lumber carriers, loaded with lumber for overseas markets as they have been completed and ready to be put into commission. These ships are classed A1 at Lloyds for 12 years. This shipyard has now on the ways and under construction four steam schooners, which are being built for the Imperial Munitions Board of the British government.

Work With All Speed

The Foundation Company's yards were established during the summer of 1917, and five wooden steamers are now on order at these yards by the Imperial Munitions Board, four of which are in various states of progress, and one will probably be launched in a short time, the others following at short intervals.

These steamers are 250 feet long, 42 feet 6 inches molded breadth and 25 feet molded depth, with a dead weight carrying capacity of about 2,800 tons. The steamers are of the well-decked type; have four extra large hatchways with five winches for rapid loading and discharging cargo. They have ample accommodation for officers and crew, and equipped with two class A lifeboats to British Board of Trade requirements, each capable of taking the whole crew. The engines are triple expansion, developing 1,000 indicated horse-power, two marine boilers of the Howden water tube type, three furnaces with forced draught for either coal or oil complete. All parts of the vessel's hull and machinery and fittings are standardized, designed with the idea of providing a good commercial, fairly speedy type of cargo carrier capable of being built in the shortest possible time (in this case less than six months) at a minimum cost. These two shipyards employ about 1,300 men and have a monthly pay roll of about $100,000.

Altogether the shipbuilding programme of the province comprises 41 wooden ships distributed amongst the various shipyards along the coast. Twelve of these are auxiliary schooners and constitute the fleet of the Canada West Coast Navigation Company. Two are for the Dominion government and 27 are for the Imperial Munitions Board. The Canada West Navigation Company's ships and the two schooners for the Dominion government are of the same type and require about 1,100,000 feet of lumber apiece. The average price of lumber has been about $36.50 a thousand feet. In British Columbia there is an inexhaustible supply of the finest timber, admirably adapted for shipbuilding purposes, with a constant demand in the foreign market.

Quality of Wood Excellent

The Douglas fir is one of the best woods for spars frequently squaring 45 inches for a length of 90 feet. It is exceptionally strong for its weight, a fact more important in the shipbuilding industry than almost any other business requires. It is important that the material be as light as the desired strength will permit, since all surplus weight increases the cost of transportation. It is one of the few woods whose strength is above the value set by the well established law of weight vs. strength.

In addition to the large timbers and planks obtainable from Douglas fir trees, the stumps yield the finest and largest ship knees in the world. The knees used in the construction of the local vessels were obtained at Cobble Hill and experts who have seen them declare they are the very best known. Cedar, spruce and hemlock abound of great size. The best timber areas are as yet, however, untouched as the mills have hitherto limited their operations to coast districts with direct water carriage. The area further inland will be reached later by railroads as the country is more developed.

Facilities for Ship Repairing

As having a direct bearing upon port interests, attention may be called to facilities for shipbuilding and general repairing directly connected with the harbor.

In the Upper Harbor or Basin, are situated the works of the Victoria Machinery Depot, having a frontage of about 360 feet, the marine ways are fitted with a cradle 280 feet long by 60 feet beam, providing dry dockage for repairing, cleaning, etc., for vessels up to 3,000 tons displacement. Larger vessels are docked by the firm at the Esquimalt drydock. At the plant are situated up-to-date machine shops, boiler shops, blacksmith shop, foundry and pattern shops, and a large wharf for receiving and storage of goods.

Supplies and Equipment Ready

Contracts have been obtained for the manufacture of the Howden marine boilers for the Imperial Munitions Board for installation in wooden steamers under construction on this coast. Hutcheson Brothers and Company, Limited, Bay Street, electrical and mechanical engineers, iron and brass founders, manufacturers of marine and stationary engines, anchor and cargo winches. This firm has a contract for the supply of winches and other deck machinery for the Imperial Munitions Board.

The Robertson Iron Works, Store Street, supply most of the heavy forgings for the steering engines and other machinery, for which they are fully equipped with steam hammers and complete appliances. The Ramsay Machine Shop, machinists and engineers, Store Street, are supplying winches for use on these steamers for the Imperial Munitions Board, together with the under-water and other special fittings and steering engines, and the Lemon Gonnason Company, Limited, capital planing mills, Orchard Street, have supplied a large proportion of the finished framing, doors, windows and house finishings for the vessels recently launched and are completing similar work for the steamers building for the Imperial Munitions Board.

Messrs. Moore and Whittington, of Pleasant Street, have supplied to both the shipyards a considerable amount of the heavy timbering for the ribs and ceilings, as well as the decking and house framing used in the various ships under construction. Messrs. Jas. Leigh and Sons are supplying to the shipyards of the Foundation Company and the Cameron-Genoa Company a proportion of the heavy timbering and decking and house work used in the various ships that have been and are now under construction.

Obtain Work of Noted Company

The firm of Yarrows, Limited (associated with the firm of Yarrows and Company, Limited, of Glasgow), builders of shallow draft vessels, have extensive shipyards at Lang Cove, Esquimalt Harbor, contiguous to the present government drydock. Their marine railway is capable of accommodating vessels up to 300 feet in length by 55 foot beam, and has a hauling capacity of 2,500 tons deadweight. Larger vessels are docked by the firm at the adjacent government drydock. Their wharf is over 600 feet in length and has shearlegs with a lifting capacity of 60 tons. Also a floating crane with a 95 feet boom capable of liting 10 tons.

The firm is at present working on a contract for propellers for the Imperial Munitions Board, for the wooden steamers under construction, and also for five sternwheelers for river service in India, 185 feet long and 30 foot beam; two have been finished and put into service, while the other two (and a third 185 feet by 35 feet by 7 feet) are under construction. After being fully assembled at the Esquimalt Yards and placed in readiness for the water, the vessels, which are of extremely light draught (about 3 feet) and practically flat bottomed, are "knocked-down" and the parts shipped to the Orient, where they are re-assembled and put in running order. They carry both passengers and freight and make about 10 knots a hour. Contiguous to the above is the government graving dock, 480 feet in length by 90 feet in width at coping level and 65 feet wide at the entrance, with a depth of water of 26½ feet. This dock is available for general ship repairing when not required by the government.

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Principal Contents of this Issue

STOP THE WATER WASTE!

Many Canadian cities are wasting water which, if saved, would increase pressure, reduce operating costs, save fuel or electrical power, and in many instances would postpone costly extensions to plant.

Every city and town engineer should make certain that none of the water which he is pumping is running to waste through leaks in his mains. Water-waste surveys will nearly always pay for themselves, even where the waterworks are in good condition, as there are invariably some small leaks which can be found and stopped. As a general rule such surveys will save large sums.

No extensions to waterworks plants are warranted in war time until it has been made certain that water is not being wasted. In Montreal, for instance, the city is being urged to finish the aqueduct sufficiently for it to be used as a source of additional water supply, or to build another conduit at a cost of hundreds of thousands of dollars. The daily capacity of the existing single conduit is about 75,000,000 gallons. The average consumption last month was over 66,000,000 gallons and went as high as 70,000,000 gallons on two days. As the consumption is increasing at the rate of about 10,000,000 gallons per annum, the civic authorities are alarmed at the urgency of the situation.

It is probable that a duplicate conduit or some other alternative source of supply should be available at Montreal, but, aside from standby capacity to meet accident requirements, it can be fairly assumed that Montreal's 75,000,000-gallon conduit would supply that city for some time to come, aided as it is by the private company which supplies part of the city, if thorough water-waste surveys were vigorously prosecuted and all leaks stopped, and if meters were more widely used.

In a recent editorial, Engineering News-Record, of New York, said: "Besides cutting down useless and harmful waste, meters afford the only just means of apportioning the cost of a public water supply among the consumers, which alone is convincing argument for their use in these times when every man's burden should not only be kept to a minimum but should also be as equitable as possible."

The Bureau of Municipal Research, of New York, in a recent report on conditions in Montreal, says: "The present schedule of water rates is inequitable and discriminatory, and should be discontinued in its entirety. Water tax is in effect a flat rate for service, and is open to criticisms that have been applied to flat rates in all forms of utility service, and which has led to their general discontinuance. The city should adopt a policy looking to the universal metering of the service. No further flat rate customers should be accepted, and the metering should be installed first on the premises of customers whose use and abuse of water is known to be the greatest, and the metering of the domestic consumers postponed to the last."

AFTER-THE-WAR PROGRAMS

English cities and towns are preparing comprehensive programs of work to be done after the war. Ideal plans are drawn, and schedules of work are prepared which will obviate local difficulties in finding employment for returned soldiers.

Such well-conceived plans of growth are long steps toward municipal efficiency and are highly desirable apart entirely from the war and its problems. Their need was emphasized last week in the report of the New York Bureau of Municipal Research to the board of control of Montreal.

"The distribution of public improvements throughout the city of Montreal," says the Bureau, "has not been in accordance with any well-conceived plan based on a comprehensive study of the city's needs. In fact, in many cases the controlling elements in securing appropriations for public works appear to have been political expediency. As a natural result of this ill-advised policy, particularly in regard to street improvements, there has been extensive construction of permanent pavements in sections of the city where the need in no way justified the expenditure.

"The seriousness of this matter would be far less were it not for the fact that the city has paid the entire cost of street improvements, no assessment being made against the property benefited. Expenditures of this character during the past decade have aggregated millions of dollars for which the city has received no direct return. This practice has contributed materially to the present financial embarrassment of the city and cannot be too severely criticized. It is imperative that the city government of Montreal without delay take appropriate action to make mandatory the levying of special assessments against the abutting property for street improvements, including resurfacing.

"The present street paving problem is one of resurfacing and construction, rather than maintenance. It is urged that immediate action be taken to organize a maintenance force, adequate to keep in repair those pavements which have recently been constructed and have not yet fallen into that condition of disrepair which is so common in many parts of the city."

The most important defects in Montreal's civic government, says the Bureau, are the general policy followed in

respect to public improvements and the lack of an adequate plan of work. Under present conditions, authorizations of public improvements such as streets and sewers are made by council and the board of control. The chief engineer of the city has no voice in the matter other than to advise those bodies upon request. This same complaint could be laid against the government of many other Canadian cities and towns, and is one of the matters requiring adjustment when preparing after-the-war programs.

Other effects of the lack of proper planning for the future are reflected in the following paragraph from the Bureau's report:—

"Two other defects in the present improvement policy of the city which have hampered the effects of administration of the department of public works are (1) authorizing the execution, irrespective of season and without providing sufficient time and adequate funds for the study of these improvements, and (2) authorizing the execution of public improvements by city forces without competitive bids. The net result of No. 1, particularly in the cost of sewer improvements, has been the excessive cost of construction."

PERSONALS

Lieut.-Col. C. N. Monsarrat, chairman of the Board of Engineers, Quebec Bridge, has been elected a director of Canada Foundries & Forgings, Limited.

William Storrie, chief engineer of the John verMehr Engineering Company, Limited, Toronto, is on his way to England to spend two months with Mr. verMehr.

Lieut. Stanley M. Sproule, of St. Lambert, P.Q., a graduate of McGill in both civil engineering and architecture, has been awarded the Military Cross for "special work in Flanders."

Lloyd Harris, president of the Russell Motor Co., who has been associated with the British War Mission in Washington for several months, has been appointed chairman of the Canadian War Mission in that city.

A. H. Harkness, consulting engineer, Toronto, has been elected by the Toronto Branch of the Canadian Society of Civil Engineers as the representative of the branch on the nominating committee of the society.

Lieut.-Col. Geo. A. Walkem, R.E., formerly of Kingston, Ont., has been placed in charge of all British railway construction work in Palestine. He is a graduate of McGill and spent some years as a civil engineer in British Columbia.

Lieut. Herbert D. Brydone-Jack, a graduate of McGill, and formerly engaged in the surveying department of the Canadian Pacific Railway, has won the Military Cross. He is attached to headquarters staff, 31st Brigade, as reconnoitring officer.

Captain Maurice Pope, of the Canadian Engineers, has won the Military Cross for gallantry in action. Captain Pope is the son of Sir Joseph and Lady Pope, of Ottawa. He attended McGill University, later entering the service of the Canadian Pacific Railway.

Major F. J. Mulqueen, graduate in science, Toronto, '13, O.C. in the 182nd Field Company, Canadian Engineers, has been mentioned in despatches and awarded the Military Cross. He enlisted from Brazil in the Royal Naval Motor Boat patrol service.

F. L. McPherson, former engineer of Burnaby municipality, and more recently filling the position of government district engineer in Nelson district, has been recalled to Victoria, B.C., to become assistant to A. E. Foreman, provincial engineer of public works.

Captain Wm. M. Everall, A.M.Can.Soc.C.E., who has seen more than two years of service in France, has been appointed assistant engineer with the Dominion Public Works Department at Victoria, B.C. Previous to joining the army he was Dominion engineer at Port Arthur, Ont.

Prof. Watson Bain, of the University of Toronto staff, has been granted leave of absence for the duration of the war. Prof. Bain, who is a professor in applied chemistry, is going to Washington, where he will be associated with Mr. Lloyd Harris on the Canadian mission there.

Sergt. A. W. Youell, of Aylmer, Ont., B.A.Sc. '11, Toronto, has received the Military Medal for services at Passchendaele. A brother, Lieut. Leonard Youell, a student in applied science, Toronto, class '16, was awarded the Military Cross for work as field observation officer at Hill 20, last August.

T. J. Wrennick, who has been in charge of the Grand Trunk terminals at Hamilton, has been made terminal superintendent for the district including the International Bridge, the Fort Erie and Bridgeburg yards in Canada, and the Black Rock and River Street yards in Buffalo. He succeeds T. W. Saunders, who has held the position since its creation six years ago. The position involves management of the bridge and a measure of control over the seven railroads which use it for freight and passenger traffic.

Arthur Surveyer and R. DeL. French have formed a partnership as Arthur Surveyer & Co., consulting engineers, with offices at 274 Beaver Hall Hill, Montreal. Mr. Surveyer, who is a member of the Honorary Advisory Council for Scientific and Industrial Research, has been engaged in consulting practice for many years past. Since 1911 Mr. French has been principal assistant engineer with R. S. and W. S. Lea, consulting engineers, Montreal, and at the same time served on the staff of McGill University as lecturer in civil engineering, in charge of the courses in municipal and sanitary engineering.

OBITUARIES

Howard C. Stone, a well-known Montreal architect, died on February 14th, from pneumonia. Mr. Stone, who was a native of Northampton, Mass., went to Montreal twenty years ago, after practicing architecture in New York City. He designed the head office of the Royal Bank of Canada, the Coristine and the Commercial Union buildings in Montreal, and the Maisonneuve factory of the United Shoe Machinery Co., of Boston, Mass., and had charge of the remodelling of the head office of the Molsons Bank, and the Canada Steamship Company's office on Victoria Square, Montreal.

H. A. Bayfield, B.A.Sc., A.M.Can.Soc.C.E., engineer in charge of the building of the government's big assembling plant at Ogden Point, where all the Imperial Munition Board's ships are to be outfitted, died at Victoria, B.C., February 13th. He was formerly superintendent of dredges for British Columbia under the Federal Government, and before that was in charge of extensive wharf construction at St. John, N.B., and other eastern seaports.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Smooth Rock Falls Power Development

Preliminary Survey Work—Plant Completed and in Operation One Year After the First Concrete Was Poured—Paper Read Before the Association of Ontario Land Surveyors

By E. W. NEELANDS, B.A.Sc., O.L.S.
Resident Engineer, Mattagami Pulp and Paper Company

THE site of this plant is at Smooth Rock Falls on Mattagami River, thirty miles west of Cochrane on the Transcontinental Railway and three miles north of the track. (Fig. 1.)

Five years ago Duncan Chisholm, of Toronto, secured from the Ontario government the lease for a pulp wood limit of 25 townships on the Mattagami River, between Porcupine and the Transcontinental Railway. It covers an area of 684 square miles and is considered one of the best limits in Ontario.

Preliminary surveys of three falls (one below and two above) were made by our firm during the summer of 1914, and about 18 miles of river traversed by the micrometer and stadia method and rough contours taken. With the data secured, Smooth Rock Falls was chosen as the site of this plant. A direct line was run between Yellow and Smooth Rock Falls to be used in locating a railway spur, the line crossing the Transcontinental Railway about a mile east of the river. On running section lines on that

Fig. 1.—Site of Plant

portion between the railway and Smooth Rock Falls, it was found that the line could not be improved on, and this is now the location of the company's spur line.

The general character of the river and banks having been ascertained, some time was spent in taking cross-section and soundings at the various falls, a camp being built for better accommodation (Fig. 2). It was found that lines running parallel to, and at right angles to the river, worked out to the best advantage. These lines were carefully lettered and numbered and permanently established for future reference. Each 100-foot square was then sectioned as the character of the ground and the importance of the location demanded. It was in this man-

Fig. 2.—First Camp Built Near Site

ner that the sections were taken at Smooth Rock Falls and the data thus acquired was constantly referred to during the entire design and laying out of the plant.

A slightly different procedure was found necessary in taking soundings but they were done along the parallel lines referred to. A 1½-inch manilla rope was swung across the river above the falls and supported at 100-foot intervals by rafts designed to keep the rope clear of the water, and to let any driftwood pass through. The banks were cleared back for about 50 feet on either side and pickets carefully set and plumbed at 10-foot intervals. A similar line was set half-way down the falls and points set by means of improvised bridges over the east and west channels. Cards were tied to the ropes at 10-foot spaces, thus marking the place to set the lead line when soundings were being taken. A 20-ft. canoe was used with three men, two to handle the lead rope and one to use the sounding rod. The sounding rod, which was a length of drill steel, marked in feet and half feet, was dropped at 10-foot intervals as the canoe came in the range of the pickets placed on the shore. The depth was called by the rear canoeman to the observer on the shore and in this manner over 300 soundings were taken in 2½ hours, the maximum depth of water being 9 feet. Elevations of the water were taken in several places and bottom elevations computed for the soundings. In fairly smooth swift water this method

worked successfully, but in surging water, such as was encountered below the falls, it was found necessary to use a large, strongly built raft held in place by three or four lead lines. As few plank as possible were used in making the raft, as it was found that the swells caught them too easily, thus making the raft very unstable and rendering accurate work very difficult and dangerous. A narrow steel tape wound on an improvised windlass and weighted by a lead ball, was used, and worked very satisfactorily.

Some time was spent in looking for gravel deposits and many test pits dug. We were unable to locate sufficient

Fig. 3.—Showing Clearing by Which Damage from Forest Fires was Avoided

quantities, so arrangements were made to get sand and gravel from the Buskego pit on the Transcontinental Railway, and it was from this pit that all material required for the job was taken.

The breaking out of the war a few days after our preliminary plans had been delivered, delayed work until the autumn of 1915, when the spur line was cleared, sectioned and staked out. The following winter the writer spent three months with the engineering staff, preparing plans, and the following spring went north in charge of the work.

Morrow & Beatty, Ltd., Peterborough, Ont., secured the contract for mill, dam and power house, and the grading of 3½ miles of spur line, 30,000 cubic yards of earth being removed. The company laid the ties and steel, standard materials being used, while the Canadian Government Railways placed the ballast for our track-lifting gang. One small sink hole developed, requiring 40 cars of ballast, but the line is straight to the townsite and the grades easy. Notwithstanding scarcity of men and material, work was completed in October, and concreting started, sand being hauled from Boskego pit and rock from the power house and tail race excavations crushed at the works.

While the spur line was under construction, 500 acres of land around the mill and townsite was cleared in such a manner as to offer the best fire protection, all merchantable timber being sold to the contractor who installed and operated the company's mill, thus saving the importation of any form lumber.

The contractors erected a splendid set of camps to house 400 men, while the company erected about twenty 8-room houses and larger camps.

Fortunately the great conflagration which swept the north country during that summer had little left on the cleared area upon which to feed, and this condition, together with organized effort and the contractor's temporary water system prevented the loss of any buildings, plant or material. (Fig. 3.) With the completion of the railway, additional men were employed and construction rushed during the severe winter and wet summer following, but notwithstanding all the adverse conditions, in-

Fig. 4.—Jumping Place Channel on Mattagami River

cluding labor troubles, the plant was completed and in operation one year from the day the first concrete was poured, involving the excavation of 21,000 cubic yards of rock, 57,000 cubic yards of earth, placing 34,000 cubic yards of concrete and 1,000 tons of reinforcing and struc-

Fig. 5.—View of Power House

tural steel, as well as the sawing, moving and placing of 1½ to 2 million feet of lumber, besides other material incidental to building construction.

The rock formation at the dam is grey laurentian

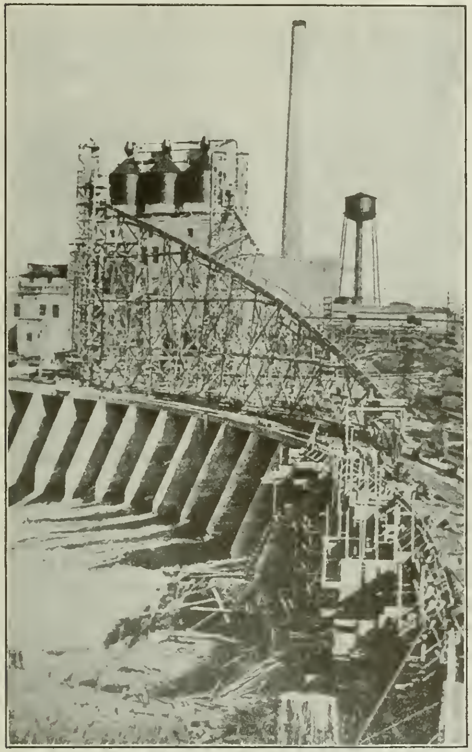

Fig. 6.—View of Dam Which Had a Radius of 333 Feet on the Upstream Surface

granite with intrusions of black basalt, two of which have been decomposed by the action of frost and water resulting in an east and west channel with a smooth island of granite in the centre, which gave the place its name. The west channel for a distance of 50 feet or more is only about 5 feet wide and possibly 40 feet in depth, and as the

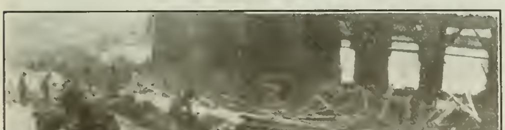

Fig. 7.—The First Coffer-dam Being Removed

east channel goes dry in low-water this place has the distinction of being the only point on the Mattagami River where a man can jump over, and accordingly has been called the "Jumping Place" by the Indians. Fig. 4 shows this channel in August, 1914, when the discharge was only 750 c.f.s., although it will take care of 1,300 c.f.s. without overflowing. The lower portion of the east channel also is 30 feet in depth but much wider, while the upper portion at the break is shallow and narrow.

It was therefore decided for the following reasons to build a circular dam, starting from the west side above the

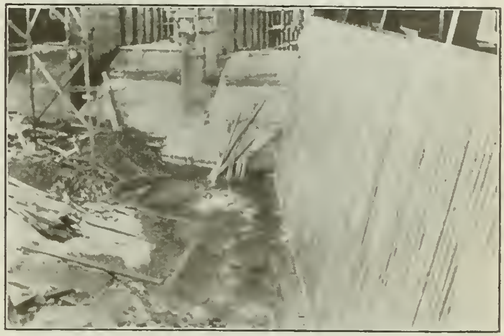

Fig. 8.—Completed Sluiceways

break in the west channel, curving over the extreme top of the island with the toe of the dam slightly above the break in the east channel, the apron being carried over the gorge on a reinforced concrete arch, while the dam terminated in the power house situated on the east side and below the falls.

In the first place, without dewatering it was impossible to ascertain the depth of the west fissure, which might prove exceedingly difficult to seal, hence our decision to keep above the falls. Furthermore, high rock on the west side above the falls made an excellent place to terminate the end abutment. By following the crest of the island, excellent facilities for construction were provided, mass concrete in the base being reduced to a minimum of 4 feet in thickness under sills, and sloping both upstream and down made a natural and ideal approach and discharge, in design, character and efficiency.

It was desirable on the east side to leave sufficient cross-sectional area between the dam and shore to insure a low velocity of approach to headworks of power house. (Fig. 5.) By placing the power house at the bottom of the falls, less rock excavation was required, and a deeper section provided in front of the racks, permitting the dam at the same time to approach more closely to the shore without reducing the section. For the above reasons, and on account of tremendous spring freshets, of which there had been no accurate measurements taken, it was considered advisable to obstruct the river as little as possible and provide as many and large sluiceways as the location would permit of. It was found that a circular dam 448 feet in length, consisting of 18 piers, 19 sluiceways and the two abutments, as shown in Fig. 6, with a radius of 333 feet to the upstream surface, met all conditions. The base of the dam is of mass concrete in the proportion of 1:3:6, while in the upper part in which the stop-log sills are embedded and anchored together with the piers, a 1:2:4 mixture was used.

The piers are spaced 21 feet centre to centre at the stop-log guides and are on radial lines. From nicely rounded noses they increase to a maximum of 5 feet in thickness at the stop-log guides and taper to 38¼ inches at the downstream end, leaving a minimum sluiceway of 16 feet in width.

The piers are covered with a reinforced concrete deck 25 feet in width, the upper surface of which is 25 feet

Fig. 9.—After the Forms Had Been Removed

above the sill. This large surface is necessary to take care of 20 British Columbia fir stop-logs 12-in. x 12-in. for each sluiceway. They are bolted together in pairs and raised and lowered by means of an electrically driven travelling stop-log hoist. Two sets of stop-log guides set 2 feet 6 inches apart, were provided to meet the requirements of the Hydro-Electric Commission.

The method of constructing the dam followed closely the facilities offered by natural conditions. The east channel, which discharged a less amount of water than the west, was first cut off by means of an L-shaped cofferdam, terminating on the east edge of the west gorge, thereby throwing all water clear of the island and permitting not only the construction of seven piers on the island, but rock work on the power house, which had to be completed before the headworks and first piers of the dam were built. No difficulty was experienced with the upper cofferdam, as the bottom was smooth and hard and the water shallow, the result being that the cribs were well lined up and the sheeting well fitted to the bottom. The crib at the corner of the L was sheeted on three sides so that when the west channel was to be cofferdammed it would act for it also. Timbers in the corner were left projecting a short distance so that in placing they lapped over the adjoining crib, thus being held solidly in position.

Before the spring freshet of 1917 the eastern gap was entirely closed, the headworks of power house and dam being well above high-water. The first cofferdam was removed (Fig. 7), the filling being used by the company to load their retaining piers for the spring drive.

After the spring freshet the west channel was closed, the water turned through the completed sluiceways (Fig. 8) and the balance of dam completed.

Waterproof expansion joints of the lead and asphalt type were placed every third pier. The greatest portion of the concrete was poured hot in a temperature many degrees below zero, with little protection save for forms. Before pouring started on the previous day's work, the frozen surface and laitance was thawed out with steam and removed. The removal of forms during the summer months revealed most excellent results, as will be seen by Fig. 9, the concrete being extremely hard, free of blisters or bad joints.

During the time the dam was under construction, work was being rushed on the power house and tail race, the latter being held up to some extent until the lower coffer-dam was made tight. The river-bed below the falls for a distance of 300 feet is only about 180 feet wide, but slopes rapidly to the centre, where it is 50 feet deep. The bottom was very irregular but was made worse by blasting operations on shore, some rock from each shot spilling into the river.

In this place cutting off half the cross-sectional area of the river, the tail race coffer-dam (shown in Fig. 10) was constructed in the following manner: A point below the tail race was chosen as a starting place and a raft constructed, in plan the size of the largest crib required. This was secured in position by guy lines and soundings taken with steel rods over every foot where the bottom timbers were to rest. Short pieces of round timber were then cut and placed together on shore, conforming with the bottom. This was then slid into the water and other timbers drift-bolted on them in the regular manner, until such time as it was considered advisable to place ballast floor. This is one of the fine points in coffer-dam work and depends on depth of water, strength of current, size of crib and material used. One-man stone was then wheeled in barrows and dumped into the crib until it rested on the bottom or required more timber, the crib all the time being held in the same position as the raft. In this manner crib after crib was built, sunk and permanently loaded, being so placed that it rapidly curved upstream into water 46 feet in depth and resting in places on a rough bottom inclined at an angle of 30 degs. Unfortunately, at the point where the water was deepest the maximum current was encountered, the deep fissure in the west channel directing a heavy under-tow directly against the cribs, requiring several large cables to retain them in position. These cribs were 50 feet x 20 feet with three ballast floors. Double sheeting made from 2-inch seasoned and dressed

Fig. 10.—Tailrace Coffer-dam

spruce plank was then placed by the divers in the order in which the cribs were sunk, the force and direction of flow helping to hold the sheeting in position in the same manner as it kept the cribs tight against each other. Water-soaked logs were continually being driven in between the timbers of the crib, requiring much time and effort to keep the face clear for sheeting. Electric lights and telephones were, however, used in the deepest place, greatly expediting the work. While this work was under way is was observed that logs driven by the force of the current were smashing the sheeting, so a break-water was constructed

in a similar manner to that of the cribs, except that it was built in two pieces only, cross-timbers being left projecting 6 to 7 feet on the side next the coffer-dam to support break-water and leave a place for clay toe, of which several thousand yards were used. Heavy canvas had previously been placed on the outside of the sheeting, particularly where the sheeting was difficult to fit properly. Two small centrifugal pumps housed in on top of the coffer-dam were sufficient to lower the water back of the coffer-dam to the required level.

As the depth of the tail race was decreased as it approached the river its width was increased, thereby maintaining the same, if not a larger, cross-sectional area, the maximum tail race velocity being not more than 3 feet per second with full gate openings.

The lower section only of the coffer-dam was removed, the balance being increased in height and strengthened, forming a breakwater during the spring freshet and thereby lowering the elevation of the tail water about 2 feet.

The power house is 98 feet in width by 74 feet in depth, constructed entirely of heavily reinforced concrete and is considered the most modern and efficient hydro-electric development in New Ontario.

The installation consists of two wheels of the vertical type rated at 4,500 h.p. each under 45 feet of head, each unit being direct connected to a 3,125 k.v.a. 3-phase, 60-cycle, 575-volt generator. A 60-kw. motor generator exciter is again direct connected to each of the large units, but the Lombard governors are belt-connected to the turbine shafts. (Fig. 11.)

The lubricating system for these units consists of three direct connected motor-driven pumps, compressor, drain, and filter tanks. The compressor supplies air for oil pressure and power for operating brakes.

The draft tubes and scroll casings are constructed entirely of concrete, the latter being exceptionally heavily reinforced, and are so designed as to offer the least amount of resistance. At the outlet the tubes are oval in shape, 22 feet wide by 15 feet in height, and gradually change to

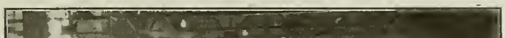

Fig. 11.—Interior View of Power House

a true circle, being 9 feet in diameter under the wheels, no two sections having the same radius of curvature or diameter of section.

Immediately back of the large units a hollow breast wall is so constructed that any possible seepage is readily drained, while back of this again, in order, are placed steel gates, each 24 feet in width, covering openings to wheels, each gate being connected to a worm-gear lifting apparatus, operated by motor or hand, singly or together, ice racks and emergency stop-log guides, and in front of the power house, supported on a structural steel framework, inclined at an angle to the normal direction of inflow, are placed the coarse wooden ice-racks calculated to stop all submerged logs, driftwood, ice, etc., which can readily be sluiced through the first and adjacent opening in the dam. A reinforced concrete deck covers this ice-rack structure and is at the same elevation as the deck of

Fig. 12.—150,000-gallon Water Tank

dam and floor of gate house. A 10-ton crane is installed in gate house and a 25-ton crane in power house proper.

The large units occupy 66 feet on the river side of the power house, the remaining 32 feet containing below the level of the main generating room, a 200-kw. alternating generator belt-connected to a 250-h.p. horizontal double-runner wheel, connected to the head works by a steel flume 54 inches in diameter and 40 feet in length.

This unit was installed early last summer and supplied power for slashing and storing the winter supply of pulp wood and also furnishing light for the entire works, including the townsite. It is still used for lighting purposes and for small machines on Sundays, when the large units are shut down. The balance of the floor space beside the flume contains two 2,500-gallon-per-minute motor-driven pumps, supplied by a 20-inch suction pipe under a head of 18 feet with pond level at 740. These pumps discharge through eight pressure filters and provide an ample supply of good water for manufacturing purposes, each ton of pulp requiring 500 tons of water.

The first floor above contains the switch-board apparatus, while the second, overlooking the generating room, contains the switch-board panels, from which place the whole plant is electrically controlled.

The contract, beside the dam and power house, included building the 150-ton sulphite mill and the wood-preparing room, the company erecting all buildings, conveyers, etc., in connection with wood storage. All townsite construction, office buildings, sewers and waterworks were also constructed by the company, while the Chicago Bridge and Iron Works erected the 150,000-gallon water-tower (Fig. 12), and the M. W. Kellog Co., of New York, the 250-foot brick smoke stack, completing same in 25 working days (Fig. 13).

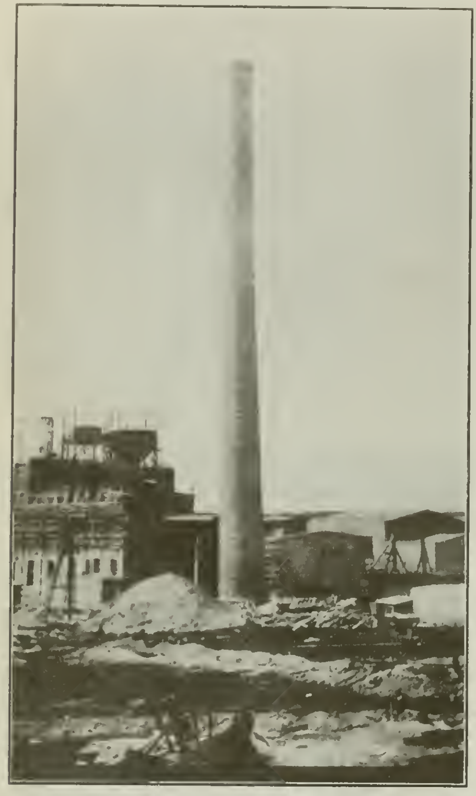

Fig. 13.—250-foot Brick Chimney Completed in Twenty-five Working Days

All the electrical equipment was supplied and installed by the Canadian General Electric Co., of Toronto.

Wm. Kennedy, Jr., of Montreal, was consulting engineer and was represented at Smooth Rock Falls by A. E. Loignon.

The contractors, Messrs. Morrow and Beatty, of Peterborough, and their engineer, James Dick, were on the ground during the entire construction.

The present town of Smooth Rock Falls is a great credit to the Mattagami Pulp and Paper Co. With its fine residences, well-graded streets, sewers and waterworks, it is an up-to-date example of what a large corporation can do along this line. The company have also erected a fine hotel and school and are supplying all their employees with free electric light and water. Taxes are a minimum and every effort is being made to attract the best class of labor to the new industry. Duncan Chisholm, of Toronto, is president of the company; S. R. Armstrong, general manager, and J. G. Mayo, local manager at Smooth Rock Falls.

VITRIFIED CLAY SEWER PIPE*

By A. R. Duff
Assistant Chemist, Experimental Station, Guelph, Ont.

THE clays used in the manufacture of sewer pipe in Ontario are confined chiefly to the district east of Hamilton, principally in the vicinity of Waterdown station on the Grand Trunk Railway. The clay is obtained from two sources in this locality, either the weathered and softened top of the Queenston (formerly known as Medina) shale, or from a transported clay, consisting chiefly of this material.

The weathering action of the shale is twofold; softening and leaching. The softening increases the plasticity of the shale very considerably, the leaching decreases the lime content.

Both processes are essential in producing a clay for sewer pipe, as smoothness of surface and the ability to take a salt glaze are obtained by using the weathered clay. These qualities could not be obtained in the finished product by using the hard unweathered shale.

The sewer pipe clay is a mixture of the weathered blue and red shale and sand, and is liable to contain certain impurities, such as small pebbles of limestone, or streaks and lenses of sand and silty clay having a high lime content. These impurities are harmful, as the limestone pebbles burning to quick-lime cause soft white spots on the pipe, and the sand or silt, if present in any appreciable quantity, decreases the working qualities of the clay in the raw state and prevents the formation of a salt glaze, at the final stage of manufacture.

The method of winning clay is as follows: The surface sod is removed by scrapers after a shallow plowing. This is followed by a deeper plowing, and the clay thus loosened is shovelled into carts.

It is suggested that if exposed surfaces are allowed to weather for several days before winning a clear demarcation is shown between clay and high lime streaks which can readily be taken advantage of.

The clay as it comes from the fields contains considerable moisture, depending on weather conditions. To pass the clay through the screens it is necessary to have it quite dry (not more than 10 per cent. moisture) and for this purpose a large drying floor built of concrete and heated by steam pipes is provided.

All operations from the field to the pipe presses help to insure a thorough mixing of the clay and a more uniform quality of product from the factory.

Belt conveyers take the clay from the drying floor to the dry pans where the clay is ground very fine. It then falls through the perforations of the pans after which it is elevated and made to fall over piano wire screens set about ten to the inch. That which goes through the

*Abstracted from 1916 Report of the Provincial Board of Health, Ontario.

screen is elevated to a storage hopper and the coarser material chutes back to the dry pan to be re-ground.

The wetting or tempering of the clay is the next step in the process. The tempering pan is fed from the storage hopper with dry-ground clay. Water is added to each charge and the mixing continues until the clay has the correct plasticity. It is then spaded from the constantly revolving pan to a belt which conveys the carefully prepared material to a hopper situated over or near the pipe press. This prepared clay cannot be stored in large quantities because its water content is liable to change due to evaporation. The behavior of the clay in the pipe press is largely dependent upon a variation not greater than 1½ per cent. in its water content. If too much water is added the clay will leave the press in a very smooth condition, but will not have sufficient strength to permit of handling on the drying floor. On the other hand, if insufficient water is added the clay is not sufficiently plastic and does not go through the die readily and is apt to cause laminations in the pipe.

The safest method of controlling the proportion of water in the tempered clay would be to use some instrument or machine that would give an accurate measure of the behavior of the water content. Laboratory tests made with the Olsen needle penetration machine showed that a difference of one-quarter per. cent. of water in the mix could quite easily be detected.

For very large pipe the clay is required not so stiff as for smaller sizes.

The greatest possible percentage of water without weakening the pipe would be the ideal condition for compact homogeneous wares.

To obtain pipes that are compact, dense and capable of being handled before firing without deformation it is necessary to apply pressures ranging from 250 to 600 pounds per square inch as it leaves the press.

In adjusting the cutter and the dies, allowance is made for the 10 or 12 per cent. shrinkage the green clay undergoes on drying and burning, so that the final product shall be of given size.

The bell, if thinner than the body of the pipe, dries more rapidly. The shrinkage from loss of water causes the outer rim to contract faster than the more moist body and when the clay lacks the necessary cohesion and strength the bell cracks. This might be overcome in the larger pipe by enriching the more doubtful sandy clays by adding some very plastic tough clay. Any pipe in which flaws develop are scrapped and returned to the raw clay drying floor.

Each pipe from the cutting platform is placed on a wooden pallet and carried on trucks to the drying floors, where it is placed bell end up.

Immediately after placing the pipe on the floor, workmen supplied with damp pads or pieces of canvas slick up any rough spots. A little more care in this operation would go a long way towards producing a better looking pipe.

In drying, care must be taken to dry all sides of the pipe evenly to avoid warping and cracking. For this, the advantage of a careful control of drying floor temperature and air humidity and the value of the hygrometer and hygrometric charts should be appreciated.

After the very careful selection of clay in the field, the most important step in pipe manufacture is the thorough and correct vitrification of the wares.

The expert burners use three methods for following the course of the burning: (1) An electric thermo-couple placed in the kiln, is attached to a recording pyrometer which draws a chart of the temperatures in the kiln. (2) Seger cones placed at strategic points in the kiln and extracted at regular intervals also give a record of the temperatures and show the point at which vitrification is complete and the pipes ready for salt glazing. (3) Small samples of the same clay as the pipes are put in similar positions to the Seger cones and by extracting these samples at correct intervals the course of the burning is followed.

There are four distinct steps in the burning of the clay products, the water smoking, burning, salt glazing and cooling.

In burning sewer pipe the term "water smoking" usually refers to that period during which any residual moisture from the drying floor process and water of crystallization is driven off.

The water present as moisture could be driven off at about 220 degrees F. or a little over boiling point, but the water of crystallization or combined water in the clay would not be completely removed till a temperature of 1,200 or 1,300 degrees F. had been reached. Speeding the process usually results in poor colored, scummed and blistered pipes. The forced drying seems to leach out to the surface soluble salts that otherwise would remain in the body of the pipe.

Depending upon the size and thickness of the wares, water-smoking takes from one to two days.

The temperature is gradually rising during the process and when water-smoking is complete the operator can see the floor from the peep-hole in the dome of the kiln and the fires have been built well upon the grates. Just so soon as the contents are red-hot from top to bottom there is little danger in raising the temperature. At a higher temperature the carbonates present in clay decompose and give off carbon dioxide. At this stage there has been very little knitting between the grains of clay and the clay is quite porous.

As the temperature rises, a point is finally reached when the edges of the clay grains start to soften. This is called incipient vitrification. At a still higher temperature the clay fuses and becomes liquid. This would be the point of fusion. Now, somewhere between the points of incipient vitrification and fusion is the correct place to stop the burning. The temperature range between these points is called the range of vitrification of the clay.

With some clays this "range" or interval between the temperatures of incipient vitrification and fusion is quite wide, say, 200 or 300 degrees F., while with other clays the range is so narrow that a burner could not possibly control his fires sufficiently to thoroughly vitrify his wares.

To determine the suitability of a clay it is important that its behavior for each step in the process of manufacture be closely studied in the factory.

Complex silicates are formed in well-vitrified clay pipe which are quite chemically inert and are not affected by the action of acids or alkalis even at boiling temperature.

Soft burned pipe will absorb as much as 14 per cent. of water, while a pipe burned to the point of fusion would have no absorption. It would be as dense as glass. The absorption then is taken as a measure of the vitrification, and a pipe is said to be vitrified when the absorption does not exceed 5 per cent. The burner of Ontario clays, to get very hard, non-porous, well-vitrified wares, must burn them as close to the point of fusion as he dares. As a general statement, it can be said that the Ontario pipes are not burned quite as hard as they might be. Some excuse for this lies in the fact that Ontario clays have a narrow range of vitrification and require very careful burning. It is not to be assumed from this, however,

that Ontario pipe is either porous or has considerable absorption; as a matter of fact it is one of the best vitrified pipes on the continent.

Care in burning but one size or thickness at a time and in keeping the floors or flues in good repair are points to be watched in sewer pipe manufacture.

Vitrification requires about sixteen hours and is followed by the salt glaze process. The salt glaze that is formed on the surface of sewer pipe is a complete sodium iron aluminum silicate that forms at a temperature of 1,800 degrees F. or over. The salt is thrown onto the fire boxes of the kiln and dissociates into sodium and chlorine. The chlorine goes up the flue and the sodium combines with the red-hot (almost liquid) clay surface to form a glass-like silicate. The higher the percentage of sand in the clay, the more readily and better does this glaze form.

When three hours have elapsed, the damper is closed and the kiln left for about twelve hours. During this time the fire doors may be opened to partially cool the kiln, then the fire boxes are completely blocked up and the kiln is left to cool slowly. This cooling and annealing takes about three days.

Annealing is a very important step in the process, as on it depends the cohesion of the pipes.

If the Ontario manufacturers are careful to produce clean glazed, good colored, well-formed pipe, we should have here pipe absolutely second to none.

ANNUAL MEETING OF ASSOCIATION OF ONTARIO LAND SURVEYORS

The 26th annual meeting of the Association of Ontario Land Surveyors was held at the Engineers' Club of Toronto, February 19th, 20th and 21st.

The morning session of the first day was devoted principally to business matters. At the afternoon session, the chair was occupied by the president, James J. MacKay, O.L.S., who in opening his address referred with pride to the fact that out of a membership of 245, the society has a representation of 39 overseas, two of whom have made the supreme sacrifice. Mention was also made of the fact that the society has already passed its silver jubilee. The president also touched on the immense work which awaits the surveyor in the coming reconstruction period. The land surveyor, he said, should be a leader in the various fields of activity; in the era of road-building which is just commencing a great opportunity is presented, and in the town-planning and developing act are opened new fields of endeavor. The opportunity for men of the surveying profession in the development of our natural resources and water powers made necessary by the lack of coal, wood and power, so forcibly shown this winter, was also pointed out.

The alleged prejudice against land surveyors which exists among engineers, was alluded to by F. N. Rutherford, chairman of the committee on engineering, who suggested that this might be overcome if a higher degree of qualification such as graduation from the faculty of applied science at any recognized university, were enforced.

J. W. Pierce, O.L.S., read an instructive paper on "Survey Monuments," which showed the shortcomings of the present system. A committee of eleven was named to wait on the provincial authorities to point out the value of permanent markings for all survey work.

In the evening, H. S. van Scoyoc, chief engineer of the Toronto and Hamilton Highway Commission, gave an interesting account of the work on the recently completed highway. An amount of local improvements and the large county and town bridges still remain to be built, he said. "The Road Development of Ontario" was dealt with by C. R. Wheelock, O.L.S., who traced the roads from the time they were mere trails until they developed into the present provincial highways. George Hogarth, O.L.S., chief engineer of the Ontario Highways Department, delivered a report on "Roads and Pavements."

On Thursday morning, the detailed business of the Council of Management was chronicled in a report by the chairman, T. B. Speight. E. T. Wilkie's report of the Committee on Land Surveying discussed some of the problems met in surveying, and Wm. W. Perrie, O.L.S., gave an instructive paper on "Problems Met With in Practical Surveying." R. R. Grant, O.L.S., gave a talk on "Descriptions," and E. W. Neelands, O.L.S., discussed the Smooth Rock Falls power development which was constructed by the Mattagami Pulp and Paper Company, of which he is resident engineer, to supply power for the 150-h.p. sulphite mill.

A very interesting paper was read by J. F. Whitson, O.L.S., commissioner of the Northern Development Branch, on "Development in Northern Ontario," dealing principally with the work of the past six years.

In the afternoon, a report of the committee on drainage was given by W. G. McGeorge, the chairman. George F. Henderson, K.C., of Ottawa, the drainage referee, was present, and threw light on a number of legal matters dealt with in the report.

Seven were given credentials during the year as Ontario land surveyors, according to the report of the Board of Examiners. The board recommended the re-appointment of Thos. Fawcett and T. B. Speight to the Board of Examiners for a term of three years.

The evening session took the form of an informal dinner at the Engineers' Club.

The election of officers and the nominations for councillors took place at the last final session on Friday morning. For 1918, the officers are: President, Herbert J. Beatty, of Pembroke; vice-president, C. Fraser Aylesworth, of Madoc; and secretary-treasurer, L. V. Rorke, of Toronto. Two councillors will be elected by letter ballot next month. Those nominated are: T. B. Speight, Toronto; James S. Dobie, Thessalon; C. J. Murphy, Toronto; F. N. Rutherford, St. Catharines; Charles R. Wheelock, Orangeville, and E. W. Neelands, New Liskeard. D. D. James and John Van Nostrand, both of Toronto, were named as auditors, and R. R. Grant, of Toronto, was appointed as representative on the Joint Committee of Technical Organizations.

Among those who attended the convention were E. T. Wilkie, F. B. Speight, L. V. Rorke, Geo. Hogarth, R. B. Laurel, J. G. Ransom, T. D. LeMay, R. S. Code, E. Fitzgerald, K. Huffman, A. P. Walker, N. A. Burwash, M. M. Gibson, H. T. Routley, John Van Nostrand, A. F. Ward, W. S. Gibson, P. A. Jackson, of Toronto; J. J. MacKay, W. W. Perrie, J. E. Jackson, of Hamilton; G. A. McCubbin, W. G. McGeorge, of Chatham; C. R. Wheelock, W. W. Christie, of Orangeville; E. W. Neelands, H. W. Sutcliffe, of New Liskeard; A. C. Young, Haileybury; E. D. Bolton, Listowel; J. W. Pierce, Pembroke; L. A. Kinnear, Port Colborne; F. N. Rutherford, St. Catharines; Jas. Dobie, Thessalon; C. R. McColl, Windsor.

CANADA'S FUEL PROBLEM*

By Joseph E. Armstrong, M.P.
Petrolea, Ontario.

LAST winter every great city in Canada was within 48 hours of starvation owing to lack of fuel. In recent years we have had two coal famines, first in 1901-2, the year of the coal miners' strike, and secondly, this year, when the severity of the weather and the extraordinary prosperity in the United States caused an unprecedented congestion of freight. A survey of conditions in the United States demonstrates that in the future there will be more coal famines than in the past, and that they will occur at shorter intervals. A recent issue of "Coal Age," of New York, says that the reserves of coal usually held over by the big companies are completely exhausted.

The people of Canada just now are gaining an impression, at considerable inconvenience, of what it would mean were the United States for any reason to cut off Canada's coal supply. Presumably there are insufficient facilities and motive power for coal transportation. Cities and towns in Canada are keeping fires alight with practically a day-to-day supply of coal, and the time may come when the United States may deem it expedient to reserve her supply of coal for her own use.

About three years ago the head of the Geological Survey Department of the United States sent a strong recommendation to Congress urging that the export of anthracite coal out of the United States should be stopped, giving as a reason that about two-thirds of the deposits of anthracite coal in the United States had already been exhausted, and that the people of the United States were facing a condition which if carried on at the present rate of consumption of this coal would deplete the mines available for this supply of coal within the next hundred years. This statement has been discussed with a great deal of emphasis in different parts of the United States. It has been favorably commented upon by many prominent men, and the condition is such as to warrant our immediate attention.

If the United States were to place an export duty on their coal to Canada, we would be then compelled to do what we ought to do to-day, to look about for a source of supply of fuel to take care of our great requirements in this regard. We would then begin to realize that some effort should be made for the development of the poorer grades of fuel that are available almost at our very door.

The attention of geologists and mine owners, also the general public, especially during the past year, have been directed to the questions of the coal supplies and reserves in Canada, and on the Continent. The large increase in the consumption of coal in recent years makes this question of vital importance to this country. Only last year, for instance, we imported $42,000,000 worth of coal into Canada. Considering the constant increase in our imports I think that this matter should receive our closest attention.

Canada Has Coal Supply

Canada has large supplies of coal situated in the Atlantic and Pacific regions; in the mountains of British Columbia and in the plains regions of the central interior. On the Atlantic and Pacific seaboards, bituminous coals are extensively mined. The interior fields supply coals of various kinds, the coals of the mountains being the most important and of the highest grade. The province of Alberta forms Canada's largest coal reserve. The coal areas of Canada have an estimated total surface extent of 109,168 square miles.

In summing up the reports of the coal deposits in the world, Canada stands second among the nations in regard to her deposits. Canada has 1,234,269 millions of tons available; the United States has 3,838,659 million tons available. Great Britain has only 189,000 millions of tons; Germany has 423,000 millions of tons available. At Pictou, N.S., coal fields show an actual available supply of 390 million tons. In addition to this, the small fields and the estimated coal area in Nova Scotia will amount to 400 millions of tons. The present output of coal for Nova Scotia is about 3,000,000 of tons per annum. The coal is largely consumed in the east, much is exported, and a large quantity goes to Montreal.

We have only two deposits of anthracite coal worthy of mention in Canada. One is located in the Rocky Mountains, and the other in the Yukon. Neither of these is easy of access, nor capable of very great development. We use anthracite in our homes because of less smoke and smell. In the West they manage to keep fires in the houses all night with low grades of coal. If our furnaces were changed to consume the smoke, we could use the lower grades of coal with comfort. Mr. Dowling, Canada's coal expert, says this can be done, and we can use $5 coal instead of $8 or $10 coal and get more heat units per ton out of it by adapting our furnaces and heating appliances to its use. From Brandon, Manitoba, east to the Atlantic coast, we are almost entirely dependent upon the United States for our anthracite coal for cooking and heating purposes.

"Scotia" Coal for Ontario

The anthracite coal deposits of North America are fast becoming exhausted. The Americans admit that they have used two-thirds of their total supply, and so we must expect that anthracite will increase in value as the years go by. We must, therefore, investigate more closely our soft coal deposits and make every effort to develop them economically. We must also induce our people to make use of the tar-products taken from soft coal which are most valuable. One of the principal products taken from soft coal is ammonium sulphate, which is used extensively as a fertilizer. We are now making a lot of toluol from Canadian soft coal taken out at Sydney Mines. This same firm has been making coke for the steel plants for years past. Soft coal can be transported from two ports in Nova Scotia, namely, Sydney and Pictou. This coal could go through our canals up the lakes to Port Arthur, and might be able to compete in price with the soft coal brought from the United States, which is delivered to the ports along our inland waters. This subject requires immediate investigation. Should an embargo be placed on coal coming into Canada from the United States this seems the most feasible way of supplying the cities on our inland waters. The government should inquire into the feasibility of handling grain east and coal west.

To obtain coal of a similar grade to that mined in Nova Scotia we have to go to the Rocky Mountains eight hundred miles west of Winnipeg. For lower grades of soft coal, nearly the whole of the province of Alberta and the southern part of the province of Saskatchewan can be called one immense coal field. Some districts in southern Saskatchewan contain soft coal from ten to thirty feet in thickness, but it is of such a nature that when it is exposed to the air it dries to a powder.

Some definite effort should be made to develop the immense soft coal area in southern Saskatchewan. The Department of Mines know where seams and exposures are

*Address in the House of Commons.

located in the bulk of this immense coal field. Experiments have been made in Ottawa by the Mines Branch within the past few years which have gone to show that lignite coal similar to that located in Saskatchewan, when used in a gas producer, can be as economically handled as regards power as if it were anthracite, provided it is used in the localities where the coal is produced.

Electricity has given tremendous assistance in conserving our coal. It is said that if the electric power already established in Canada were dispensed with it would be necessary to import twice as much coal as is at present consumed in order to supply our people. By developing electricity we have made enormous savings in fuel, and we should investigate at once and see how much farther we can go in this regard. If we nationalize our railroads the government may feel justified in electrifying large portions of our main lines, and in this way conserve the coal for other purposes. The Chicago, Milwaukee & St. Paul Railway hauls by electric power freight and passengers over 440 miles of its road, and is at present electrifying an additional 250 miles.

The ordinary growth of our provinces calls for cheaper power and cheaper fuel; and the development of our western provinces will depend to a large extent on the supply of cheap fuel and power. For, notwithstanding the existence of the enormous deposits of coal in the extreme eastern and western portions of Canada, certain of the provinces are dependent on foreign sources for their supply. Conditions, however, may not continue as they are to-day. They may change suddenly and we may find ourselves deprived of fuel from the United States without warning. For such an event, we have made no provision; we have accumulated no extra store to meet such an emergency, but import only what is needed annually.

The Peat Bogs of Canada

It may be safely said that there will be no permanent reduction in the price of coal; rather it is reasonably certain that there will be a gradual but steady increase. Fuel will become higher as the years go by. The cost of development of heat from water power, in addition to maintenance and management, does not encourage us to believe that we will be able to use electricity as a poor man's fuel for many, many years to come. The price of anthracite and other coals is advancing largely because of exhaustion of the thicker beds, and increased costs of working, freight and transportation facilities. Anthracite coal is fast becoming the fuel of the rich.

In addition to this, manufacturing establishments are bound to increase and the coal consumption for power purposes will likely develop more rapidly. As coal becomes dearer, the difficulty and uncertainty of the supply becomes more accentuated, and the importance of a substitute fuel becomes more urgent. If, therefore, the great peat bogs of Canada could be successfully converted into fuel which would be cheaper than wood or coal the advantages thus conferred upon the future inhabitants of Canada and the United States could hardly be overestimated. The difficulties to be overcome do not appear to me to be very great when the attendant benefits are taken into consideration. The kinds of fuel available in Canada are: The wood still standing, our oil deposits, the oil contained in oil shales, gas, lignite coal, water powers (or white coal), anthracite coal, bituminous coal, and our peat deposits.

Peat is incipient coal. It is made up of the more or less thoroughly decomposed and carbonized remains of plants accumulated under conditions that have prevented their complete transformation into gaseous and mineral matter. The successive stages in the process of carbonization, as it is reported in nature, is first peat, then lignite coal, anthracite and graphite, a form of carbon. For centuries, peat has been extensively used for domestic fuel by the peasantry of northern Europe. An important source of additional fuel for the more immediate future in Canada exists in our extensive peat bogs. These, and the great lignite areas of the northwest occupy a middle ground between coal on the one hand and such vegetable fuels as wood, etc., on the other.

Peat Gave Satisfactory Service

For many years past efforts have been made to develop the peat areas in Ontario and Quebec. A large amount of money was frittered away by careless and useless endeavors to produce this material in a manner in which it might be marketable. However, some six years ago the government decided to make a practical investigation into the peat producing areas of our country, and, if possible, demonstrate the advantages to be derived from peat production. They sent representatives to Holland, Sweden, Denmark, Germany and Russia to gather data and material that could be utilized to advantage in Canada. On the return of these representatives the government purchased 300 acres of the peat bog at Alfred, about forty miles out of Ottawa, and prepared to demonstrate the commercial feasibility of the manufacturing of peat fuel by the employment of a process which is well known in Europe, and which was the only process for manufacturing peat economically. The government manufactured 2,000 tons of peats in that bog; they sold this peat in Ottawa and vicinity to householders and manufacturers for the purpose of introducing that form of fuel to the public and to obtain expressions of opinion regarding this fuel for domestic purposes. The various users of this fuel almost invariably expressed their satisfaction with peat as fuel. They further expressed their keen desire to continue the use of this fuel. I have 150 letters from people who used peat as fuel, and, with the exception of two or three, all speak in the highest terms of its heating qualities, its economy and efficiency.

After the completion of their experimental work, the Mines Branch felt that they had accomplished all that they should do, *i.e.*, the demonstration that this peat could be manufactured at a low cost and transported economically, and that as a fuel it was satisfactory. The Mines Branch felt that further development should be left to private individuals. They disposed of the plant and acreage to a firm who commenced the development of the industry. The private individuals then made some improvements to the plant, and during the year 1914 expected to carry on extensive developments. They were well under way with this work when the war broke out, but being supplied with a limited capital, they were seriously handicapped, and were compelled to close down their plant for lack of money to continue its operation. I regret to say that the plant is now in the hands of a receiver.

From the government's development of the peat bog at Alfred, it was proven conclusively that peat could be manufactured into blocks suitable for use in industries and in private homes at an actual cost of $1.75 per ton.

That was the price manufactured on the ground. Indeed, this was the actual cost of the production of the 2,000 tons of peat referred to. The railway charged one dollar per ton for its transportation to Ottawa, a distance of forty miles.

However, the peat was delivered at $5 per ton to manufacturers and householders, and from many sources I have obtained definite information sufficient to assure me

that for residential purposes, in grates, in cook-stoves, in the ordinary heater, this has proved to be an ideal fuel. This is a practical demonstration of what can be accomplished, and a good reason why the government should act. It is true that anthracite coal has more heat units per ton, but the use of anthracite coal entails greater wastage, owing to incomplete combustion, and a larger percentage of ash. This is not necessary in the consumption of peat. Peat fuel is easily lighted, and it is not necessary to use a greater quantity than is required for cooking or heating at one time, while, on the other hand, anthracite undergoes very great wastage in this regard.

Russia Uses Peat

The sale of machines for the manufacture of peat in Russia in the years 1912 and 1913 shows an increase of 400 per cent. It is estimated that Russia is producing annully ten million metric tons of peat fuel, out of which seven million tons are manufactured in the seven central Russian provincial governments. The United States, exclusive of Alaska, is estimated to have 11,200 square miles of peat bogs, averaging nine feet in depth, and containing nearly 13,000,000,000 tons of fuel, worth, at $3 a ton, $39,000,000,000. Canada has 37,000 square miles of known peat bogs, but these form probably but a small fraction of the total, constituting a potential national asset of enormous value. The peat resources of Canada exceed those of any other country with the exception of Russia. During the period from 1908 to 1914 the Mines Branch in Canada located, mapped and investigated 140,000 acres of peat bogs in Ontario, Quebec, Nova Scotia, Prince Edward Island and Manitoba, all convenient to railways and markets, estimated to be capable of yielding 115,000,000 tons of fuel and 10,500,000 tons of peat moss litter. Why do we not make use of the information obtained by our government experts? Seven Ontario bogs within convenient shipping distance of Toronto will yield 26,500,000 tons of fuel. Four bogs within a few miles of Ottawa are estimated to contain over 25,000,000 tons. Seven bogs in the Montreal district could furnish that city with 23,500,000 tons of fuel. Five bogs along the St. Lawrence, below Quebec and convenient to that city by water, could supply 16,250,000 tons of fuel and 5,750,000 tons of peat moss litter. Nova Scotia bogs examined in Yarmouth, Shelburne and Lunenburg counties will produce 6,250,000 tons of fuel and 500,000 tons of litter. Six bogs investigated in Prince Edward Island can furnish 1,250,000 tons of fuel and over 1,000,000 tons of litter. Seven bogs examined in Manitoba will produce 2,000,000 tons of fuel and 2,500,000 tons of litter.

As to the comparative heating value of peat fuel as delivered to the consumer, it may be said that, comparing the actual heating values, one ton of hard coal is equivalent to 1½ tons of peat with a moisture content of 25 per cent.; but, in order to arrive at a fair comparison, it is necessary to understand and carefully consider certain factors which, under certain conditions, would turn the scale in favor of peat fuel. As a fuel for cook-stoves, ranges, etc., peat fuel will prove more economical than anthracite, since, with coal, the fire must be burned continuously, and, moreover, the refuse, *i.e.*, ash, contains a very large proportion of combustible matter.

The manufacture of sulphate of ammonia is a matter of great importance to the people of Canada. Our peat bogs in Canada are high in nitrogen, running about two per cent. In Italy they are running their peat bogs with a little over one per cent. of sulphate of ammonia. Ammonia sulphate is a very valuable artificial fertilizer, for which there is a continually increasing demand in almost all parts of the world, and a ready market could be found for all the sulphate of ammonia that could be produced in Canada.

At a time like the present when stock is being taken of the natural resources of the country, the importance of these investigations will be readily recognized. The estimated yield of 19 bogs in Ontario and Quebec, if used to produce ammonium sulphate, would give a production of 81,696,416 tons of fuel. With a production of sulphate of ammonia amounting to 4,025,525 tons at a valuation of $65 per ton, which is a very low estimate, the value would amount to $261,659,775.

Intense agriculture has filled the granaries of the world, but fertilizers have become absolutely necessary. Soil fertility is urgently demanded. Appetite has come with eating and our demands and wants are increasing day by day. Inoculation of soil has become an established success. Bacterized peat has been used most successfully as a medium for this purpose. Experiments in England made by Professor Bottomley, Botanical Laboratories, University of London, Kings College, as described in a book entitled "Spirit of the Soil," written by C. D. Knox, shows that treated peat gives as much as 50 to 80 times greater results than the best rotted stable manure, that it is free from smell, dust, weeds, disease spores and insect pests, is clean and pleasant to handle. After seven years of experiments, the American Board of Agriculture are distributing a similar preparation to farmers and recommending its use. Bacterized peat opens a field for every farmer and gardener to undertake important scientific work, in order to increase the yield from the land.

In addition to this, Dr. Eugene Haanel, the head of the Mines Branch, makes the following estimate:

That the gas available in working the large Teefield bog for sulphate of ammonia would produce 4,000 h.p. continuously for 86 years, a total of 344,000 h.p. The total power gas available in conjunction with the utilization of all the bogs in Canada would amount to over 5,000,000 b.h.p.

Peat burns with a much smaller air supply than coal, consequently less heat is wasted than with the greater draft required to burn coal.

The Duty of the Government

I believe it is the duty of this government to take over certain peat bogs and lignite mines and furnish the material at cost to our people. Greatly increased prices for the coming winter must be expected, and unless some immediate action is taken, great hardships are bound to ensue. The peat bog at Alfred, Ont., is capable of immediate development, and at least 1,000 tons of peat per month could be manufactured in this bog during the summer and fall. After the material is manufactured, it is up to the municipalities to purchase the peat and see that it is delivered at cost.

In the western provinces, lignite coal should be made available for distribution and I believe that a sufficient quantity of soft coal should be brought from the mines at Sydney or thereabout, up the St. Lawrence, and distributed to the municipalities, if for no other reason than as an experiment. The day may soon come when elevators will be built in Sydney harbor and boats carry coal west and wheat east. I cannot urge too strongly on the government the need of immediate attention to this whole fuel problem.

The Huntting Lumber Company mill site on False Creek, Vancouver, embracing 425 feet of valuable water frontage, has been purchased by John Coughlan and Son, to serve as an addition to their steel shipbuilding plant.

CENTENARY OF THE INSTITUTION OF CIVIL ENGINEERS

The Institution of Civil Engineers, the pioneer engineering society, celebrated its centenary last January 2nd. It was on January 2nd, 1818, that it was established by eight young men, who met for that purpose in the Kendal coffee-house in Fleet Street, London, England. It was fortunate in securing as its president, two years after its birth, Thomas Telford, the foremost engineer of his day and one of the leading engineers of all time. Holding the office until his death in 1834, he devoted much of his time during his life to furthering its interests, and at his death bequeathed a sum of money for the establishment of the Telford Medals and Premiums, which have ever since served to encourage the presentation of original communications at its meetings. It was in his time also, in 1828, that its position was established by the grant of a Royal Charter, which contains the famous definition of civil engineering as being: "The art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks, for internal intercourse and exchange, and in the construction of ports, harbors, moles, breakwaters, and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns." The growth of the membership was not very rapid. More than thirty years were required before it reached 1,000, and another thirty before it was 5,000; the highest point was attained just before the war, when the roll contained 9,266 names.

1916 REPORT OF PROVINCIAL BOARD OF HEALTH OF ONTARIO

The following facts with respect to sewer extensions in the province of Ontario and the extent to which typhoid fever has been eliminated as a result of use of chlorination, are taken from the report of the Provincial Board of Health for 1916:—

Applications approved by the Board relating to sewerage and waterworks systems and extensions thereto, amounted in the year to the sum of $2,010,070.42 (estimated costs) and are summarized as follows:—

	Applications.	Estimated cost.
Sewer extensions	123	$1,226,260.90
Sewage disposal works	7	97,872.00
Waterworks extensions	56	369,035.42
New water supplies	4	316,902.10
Totals	190	$2,010,070.42

An effort has been made to prepare standards for municipal records, proposal for bids and estimates, bid and estimate, bond, contract and specifications for sewer construction together with certain standard details of construction. With uniform methods it should be possible for a government inspector to deal directly with the interpretation of the specifications and with the contractor. Under existing conditions the matter has to be referred back to an engineer whose responsibility frequently terminated with the acceptance of the plans and letting of contracts.

The question of regulations governing the installation of plumbing and sanitary conveniences in the province of Ontario has been considered and a tentative proposal has been prepared. A standard specification for soil pipe is suggested regulating the sizes, dimensions and weights of soil pipe. This will doubtless control fittings in the eastern portion of the Dominion.

The situation with regard to water-borne typhoid fever in the larger towns is very satisfactory. The accompanying table shows a gradual elimination of typhoid during the past two years. With municipal support in continuing the dosage of chlorine required, it is possible to eliminate typhoid as a serious factor in our vital statistics.

Table No. 1.—Rate Per 100,000 Population

Cities.	1908	1909	1910	1911	1912	1913	1914	1915	1916	City Average 1908–16	Treatment. Source of Supply.
Brantford	53	24	72	77	17	24	11	11	24	34.7	Chlorination, 1914.
Fort William	....	....	....	85	33	30	21	22	9	25.0	None, Loch Lomond.
Galt	43	11	42	31	19	27	17	0	25	23.8	None, Springs.
Guelph	21	69	27	13	6	6	12	12	0	18.4	Chl. 1915, Springs.
Hamilton	19	16	15	24	8	14	7	6	4	12.5	None, Lake Ontario.
Kitchener	15	15	43	7	19	6	11	5	0	13.4	None, Wells.
London	12	6	4	17	10	3	9	0	2	7.0	None, Springs & Wells.
Niagara Falls	....	....	....	....	....	....	....	9	27	18.0	Chl. 1913, Niagara R.
Ottawa	31	24	28	....	....	19	17	24	18	23.0	Chl. 1912, Ottawa R.
Peterborough	18	6	29	17	10	10	25	14	14	15.9	Chl. 1916, Otonabee R.
Port Arthur	....	....	....	....	....	....	....	5	21	13.0	Chl. 1913, New source, '14
St. Catharines	....	24	24	71	22	27	6	0	22	21.7	Chl. 1914, Welland Canal
St. Thomas	49	34	20	19	19	50	0	29	29	27.6	Chl. 1913, Filters, Wells
Stratford	14	34	34	13	20	6	6	17	12	17.3	None, Wells.
Toronto	21	25	46	24	14	18	9	2	7	17.8	Chl. 1909, Filters 1912-16
Woodstock	32	21	21	42	30	10	0	10	28	20.6	None, Springs.
Average by years	25.2	23.7	31.1	30.0	17.4	17.5	10.0	9.8	13.4	19.8	

The above rates do not appear to be greatly influenced by water supply.

Table No. 2.—Rate Per 100,000 Population

Cities.	1908	1909	1910	1911	1912	1913	1914	1915	1916	City Average 1908–16	Treatment of Water Supply.
Belleville	71	40	50	19	37	18	17	63	81	44.0	Chlorination 1916
Chatham	49	68	39	38	44	58	16	8	46	40.6	Filters 1895
Fort William	111	106	83	Protected.						10.0	New Source 1910
Kingston	31	31	78	26	32	25	43	28	5	33.2	Chlorination 1912
Niagara Falls	84	26	60	90	44	85	34	protected		60.4	Chlorination 1913
Ottawa	....	....	....	101	108	Protected.				104.5	Chlorination 1912
Port Arthur	138	164	178	121	163	146	50	protected		137.1	New Supply and Chlorination 1913
Sarnia	110	82	101	148	139	45	26	34	60	82.7	Chlorination 1913
Sault Ste. Marie	68	90	154	280	85	127	84	24	31	116.6	Chlorination 1913
Windsor	63	56	49	84	38	10	27	35	29	37.8	Chlorination 1913
Average by years.	80.5	73.6	88.0	102.1	76.6	64.7	37.1	32.0	42.0	66.2	

The above rates appear to be influenced by infected water supplies.

WOULD PROHIBIT USE OF ELECTRIC POWER FOR DOMESTIC HEATING

In order, if possible, to prevent the more extended use of electricity for purposes of heating, and in the desire to conserve electric power more specifically for essential work in connection with the manufacture of munitions, the city council of Niagara Falls, Ont., has passed the following resolution:—

"That, owing to the shortage of electric power needed for the making of munitions and other commodities used for the prosecution of the war, in the opinion of the council, heating by electricity should be prohibited for these economic reasons:

"That it is used in the months when the peak load is the highest and when power is produced under adverse weather conditions, owing to ice forming at the source of supply.

"That, with electric current at one cent per kilowatt, power is four times the cost of coal at present prices."

SUPPORTING STRENGTH OF SEWER PIPE IN TRENCHES

FOR some time past the Iowa Experiment Station at Ames, Iowa, has been conducting a series of experiments on the supporting strengths developed by sewer pipe and drain tile in actual shallow ditches, with different methods of laying the pipe. A bulletin has recently been issued in which the results of these experiments are set forth. Extracts from this bulletin follow:

First—The "ordinary supporting strengths" (which are those developed with the "ordinary" pipe-laying method) are equal, with close approximation, to the cracking loads in laboratory tests with standard "sand" bearings.

Second—The supporting strengths developed with the "first class" pipe-laying method may be set safely at least 20 per cent. greater than the "ordinary supporting strengths" of the same pipe.

Third—The tests at Ames, Iowa, have shown that it is possible to design and build concrete-cradles of reasonable cost which will increase the cracking supporting strength of sewer pipe and drain tile 100 per cent. or more above their "ordinary supporting strengths." However, a large amount of experimental investigation (by bedding pipe in concrete-cradles of different designs and loading to destruction) is still needed to determine the best designs for concrete-cradles. This work will be prosecuted at Ames as rapidly as resources permit.

It was formerly thought that the effects of differences in pipe-laying conditions upon the supporting strengths developed by sewer pipe and drain tile in ditches must be so great as to make hopeless any attempt to systematize the subject in a scientific manner. Extensive tests of sewer pipe and drain tile in recent years, however, have demonstrated conclusively that the effect of differences in pipe-laying conditions upon the supporting strengths developed in actual ditches is much smaller than had been supposed.

Data from the Ames tests show that even such extreme variations in conditions affecting the supporting strength of sewer pipe as those between distribution of the pressures at top and bottom fairly uniformly over 71 per cent. of the total diameter, through standard "sand" bearings and concentration practically on the centre lines, by "three-point" bearings, affect the cracking loads only to the extent of about 30 per cent. of the "ordinary supporting strengths." Extensive data published in Bulletin 36 of the Iowa Engineering Experiment Station show the same percentage of effect on drain tile, also.

Since the effect of such extensive variations in loading conditions is so small, it is quite apparent that there is comparatively little difficulty, after all, in dividing pipe-laying conditions systematically into a small number of classes, and in ascertaining the relations of each class to the supporting strengths developed by sewer pipe and drain tile in actual ditches.

The classes of pipe-laying methods frequently encountered and their relations to the supporting strengths developed by sewer pipe and drain tile in ditches are as follows:

"Impermissible" pipe-laying methods are those in which the bottom of the ditch is not suitably rounded to fit the underside of the pipe, or in which hub-holes are not properly dug, or in which the refilling material is not placed to fill all around the pipe, or in which other impermissible defects of similar general character occur. Impermissible pipe-laying methods should never be tolerated. They weaken the supporting strength of sewer pipe and drain tile very seriously.

The "ordinary" pipe-laying method is that in which the underside of the pipe is carefully bedded on soil for 60 to 90° of the circumference, suitably rounding the bottom of the ditch for this purpose and digging hub-holes for all pipe with hubs, and in which the pipe is surrounded by soil placed with ordinary care.

"Ordinary" pipe-laying is used extensively in constructing large tile drains under the direction of drainage engineers, and in constructing pipe sewers in villages and small cities. There are many variations in the wording of specifications for pipe-laying methods which should be classed as "ordinary," but the effect of minor variations in the method is not great upon the supporting strength developed in the ditch.

The largest sewer pipe and drain tile show not more than 1/50 in. movement outwards of the extremities of their horizontal diameters under cracking loads, which is not enough to develop sufficient side resistance to affect the cracking load materially, even when the ditch filling is thoroughly tamped, as with "first class" pipe-laying. Nevertheless, all spaces around the pipe should be completely refilled with ditch-filling material, for even untamped refilling between the sides of the pipe and the sides of the ditch is of great value in preventing the collapse of pipe sewers after they crack. Many miles of cracked pipe sewers and large tile drains are still rendering good service for this reason.

The loading conditions on sewer pipe and drain tile laid by the "ordinary" methods are closely reproduced by the standard "sand" bearings for laboratory tests of supporting strength. In fact, the standard "sand" bearings were devised after a careful study of ditch loading conditions, in an attempt to reproduce them as far as practicable. The field tests at Ames demonstrate conclusively that:

The "ordinary supporting strength" of sewer pipe and drain tile is equal, with close approximation, to the cracking load in laboratory tests with the standard "sand" bearings. The "ordinary supporting strength" is defined as the supporting strength to carry loads due to or transmitted through ditch-filling which sewer pipe and drain tile will develop in actual ditches with the "ordinary" pipe-laying method.

The "ordinary supporting strength" of sewer pipe and drain tile is a very important factor, on which all calculations of supporting strength with different pipe-laying methods should be based, by the use of proper ratios, for the reason that in the great majority of cases of cracking of pipe in actual ditches the cracking occurs at loads just about equal to the "ordinary supporting strength" of the pipe which cracks. This has been demonstrated by very carefully and patiently collecting and studying the detailed data of all cases of cracking published or of which data could be collected during several years of correspondence and personal field investigation.

The "first class" pipe-laying method is that in which the underside of the pipe is very thoroughly bedded on soil for at least 90° of the circumference (suitably rounding the bottom of the ditch for this purpose and digging hub-holes for pipe with hubs) and the entire pipe is surrounded with thoroughly compacted soil, all under the direction of a competent inspector constantly on the work.

The "first class" pipe-laying method is extensively used in pipe sewer construction in large cities, and generally in all important pipe sewer construction carried out under an adequate, well-organized and thoroughly competent engineering force. There are many variations in

the wording of the specifications by different engineers, but the corresponding variations in practice produce only minor effects on the actual supporting strength of the sewer pipe and drain tile in ditches.

The use of the "first class" pipe-laying method ought to be greatly extended beyond present practice.

The supporting strength to carry loads due to or transmitted through ditch filling which sewer pipe and drain tile will develop in actual ditches with the "first class" pipe-laying method may be set safely at at least 20 per cent. greater than the "ordinary supporting strength" of the same pipe.

The best engineers seem pretty well agreed that the use of concrete-cradles in pipe-laying ought to be greatly extended beyond present practice in the construction of all pipe sewers of 15 ins. and larger diameters.

There is at present no generally accepted practice as to the detailed dimensions and other characteristics of concrete-cradles for pipe sewers of different diameters, and only a very few tests have been made to ascertain definitely the actual effect of any particular design of concrete-cradle, in increasing the actual supporting strength of the sewer pipe or drain tile in ditches. The designs of concrete-cradles are made by rule of thumb, and vary with the whims of the designers, between wide extremes for the same service.

In the field tests at Ames, Ia., of the supporting strengths of sewer pipe and drain tile in actual ditches a number of concrete-cradles of different designs have been subjected to actual test, with general results as follow:

First—It is possible to design and build concrete-cradles of reasonable cost which will increase the cracking strengths of sewer pipe and drain tile under loads due to or transmitted through ditch filling 100 per cent. or more above their "ordinary supporting strengths."

Second—Variations of the dimensions and other characteristics of concrete-cradles (for the same diameter of pipe and other conditions) affect the increase of supporting strength greatly. The real effect of variations can be ascertained reliably only by actual tests to destruction.

Third—A large amount of experimental investigation of concrete-cradles of different designs tested to destruction are necessary to determine the best designs and the real values of concrete-cradles of particular designs.

It has been suggested that the supporting strengths which sewer pipe and drain tile develop in actual ditches could be materially increased by bedding them on and completely surrounding them with tamped gravel.

Accordingly, this type of bedding was tested in an actual ditch at Ames, Ia., in 1916. The test indicated that complete gravel bedding increases the supporting strength of sewer pipe to a value somewhat higher than that for "first class" pipe-laying or, say, to at least 25 per cent. above the "ordinary supporting strength" of the same pipe.

It is not sufficient that the average supporting strength developed by sewer pipe and drain tile in a particular ditch shall be barely equal to the loads on the pipe. Unless there is a proper excess of supporting strength over the load, those pipes which are weaker than the average will be cracked by the load and some unusual contingency may so increase the load as to crack even stronger pipe. A factor of safety is necessary for sewer pipe, just as for other engineering structures.

The proper way to determine just what factor of safety is necessary in order to prevent undue danger of cracking of sewer pipe and drain tile in ditches is to make a careful study of all known cases of actual cracking in ditches, and a similar study of the detailed data of as many cases of sound pipe in ditches as practicable. The authors of the bulletin have been making such a study for about eight years, and conclude that:

A study of all known cases of cracking of sewer pipe or drain tile in actual ditches, and of the detailed data of a large number of cases of sound pipe in ditches shows that a safety factor of $1\frac{1}{2}$ is both necessary and sufficient to prevent cracking.

ROAD MAINTENANCE AND REPAIR*

By Alexander W. Graham
State Highway Engineer, Missouri.

To write something really "new" concerning the maintenance of roads is rather a difficult task, as the development of this phase of highway work has been steadily advancing and each succeeding step is so closely allied to the one preceding that it is practically known, even though not extensively used. However, the maintenance of roads in Missouri is decidedly *new* to a greater part of the State, and I will discuss some of the problems which are encountered.

As the foundation practically of all roads is primarily earth, and before any hard surface can be applied, a well-constructed earth road must be provided, I will begin at the bottom and point out some of the ordinary problems which are encountered in reconstructing, repairing and maintaining earth roads.

First of all, we encounter the one real problem of road work, namely, drainage. Personally, I would like to see the word "drainage" printed in every known language and pasted in the hat of every man who is connected with road work. In Missouri our old friend, the road overseer, with his cohorts who do not need plans or stakes to work from, has presented the state with some real works of art. The side ditches, or spaces where they should be, ramble over hill and dale and deliver their burden wherever convenient and in a large number of cases retain their burden until it can be distributed and thoroughly incorporated with the road itself. Sometimes the brilliant idea of carrying the water across the road is put into effect by building a dam and forcing the water to cross over the surface of the road. These dams (rightly named) are commonly known as "thank you mams," so-called, I suppose, from the fact that you receive the same number of jerks in passing over one of these obstructions as there are words in the phrase. I would add that I have heard these affairs named by the grouping of three words, but not the words referred to above.

But, seriously, the drainage of our roads is a very vital problem and involves in itself many different problems. Many of our culverts are too small, improperly built and have not been kept clear of obstructions. I am glad to say, however, that the old wooden culvert has about finished its work and is being supplanted by more permanent types of construction.

In the construction of permanent culverts we encounter the problems of size, grade and type. As determining the size of waterways is largely a matter of judgment, owing to the fact that, regardless of what formula you may use, your result will depend upon the assumptions made, I am reminded of a theory practiced by a friend of mine when estimating the cost of construction work which was to

*Paper read before the American Road Builders' Association.

estimate according to all known rules, double the result and add six hundred dollars.

Having decided upon the area of waterway required, the next problem is how to secure same without disturbing the grade of the road and at the same time keeping the flow line so that the culvert will not fill up with earth, etc. This result is not always possible, but by varying the shape or type of culvert, good results can generally be obtained. In a majority of cases, the defects mentioned above can be taken care of when laying the grade line, etc.

In the past, a great many of our roads were graded to the full width of the right-of-way, and, if in a cut, the outside ditch lines were left vertical. In some soils reasonably good results have been obtained, but in a majority of cases the banks will cave in, which not only fill up the ditches, but will damage the adjacent property. I think a reasonable slope both ways from the ditches is preferable, as it will permit the seeding of the slopes and when a good soil is obtained, frequent use of a mower will keep the slopes in a condition not only pleasing to the eye, but will prevent erosion and slides.

The old idea that grading a road meant shaping up the old travelled way regardless of grades, location, sharp turns, etc., has fortunately been supplanted by the growing demand for easy grades and turns and has given the highway engineer the opportunity to demonstrate the value of cuts and fills, better locations and alignment. The item of cost is rather troublesome as it is hard to convince local authorities that mere grading should be so expensive.

After the road has been reconstructed in accordance with standard rules governing grade, cross-section, drainage, etc., the problem of maintenance presents itself.

The maintenance of any road is the keeping of the surface dry and firm, free from ruts, holes, etc. This can be accomplished in various ways, but we Missourians pride ourselves on being the foremost exponents of the road-drag, and I do not believe there is any more practicable or economical way of maintaining an earth road than by the use of the drag. The type or kind of drag is a much-discussed detail, but I will not go into the subject here. The principle of the drag is to smooth the surface and prevent the road from flattening out and losing the crown, which, of course, is absolutely necessary if you expect the water which collects on the surface to reach the side ditches quickly.

In designing a road-drag it is well to keep the above-mentioned details in mind. The time to use the drag is when the surface of the road is moist, but not wet, as some soils stick to the drag if too wet. The effect of the drag is very similar to puddling clay in order to get a more dense mixture.

In the maintenance of all types of roads I am somewhat of a crank on one thing, *viz.*, the removal of snow from the roads as soon as possible after the storm is over. The first vehicle which travels over a road after a snow storm "breaks a track" and this is closely followed by each succeeding vehicle until a compact snow cushion is formed, upon which the entire traffic of the road is concentrated. It is obvious that this concentration of traffic upon such a small area of wearing surface will be excessive, and will cause two narrow depressions or tracks to form upon the road surface in which will collect the water from the melting snow and this will soften the road-bed and deep ruts will result.

The snow can be removed by reversing the action of the road-drag and dragging away from the centre, or by road-graders, snow-plows, etc., keeping in mind, however, that the snow should not be piled into the side ditches, as this will interfere with the drainage. After the snow has been pushed to either side it is well to go over the road with a shovel and break a channel through to the ditches at frequent intervals, as this will permit the melting snow near the travelled way to reach the ditches quickly and not be held near the road until the entire snow shoulder melts.

Sand-Clay and Gravel Roads

As the principles governing the construction of these two types of roads are very similar, I will discuss the maintenance of them as one subject.

The principal problem to solve when constructing either a sand-clay or gravel road is the bond, as neither sand nor creek gravel contain a bonding material which will tie the materials together firmly enough to withstand the traffic. It is impossible to write a specification which will be applicable in all cases, as the materials found in different localities are so different in character, and in a majority of cases, a careful study of the materials is necessary before any definite conclusion can be reached. It is well known that enough clay must be added to fill the voids and bind the gravel or sand together, but the determination of the proper amount is difficult, as too much clay is apt to cause the surface to "pick up" and not enough will cause the surface to ravel.

Assuming that the proper amount of clay is added, then the problem of compacting the mass presents itself. In handling this detail I am afraid that I differ from most engineers for the reason that I question the value of attempting to compact a gravel or sand-clay road with a roller. Of course, rolling is beneficial, but to my mind there is only one thing which will really compact a sand-clay or gravel road and that is the traffic. I do not think either type of road can be completed before it is opened to travel. This method is necessarily rather inconvenient to the public, but if the road is kept free from ruts and holes by frequent use of the road drag, it will not require many months of travel to compact it.

Many engineers advocate oiling a sand-clay or gravel road, but I am not very enthusiastic for this type of maintenance. My observation of oiled gravel roads is that the action of the oil, with the possible exception of laying the dust, is more harmful than beneficial. The physical characteristics of gravel make the oil act more as a lubricant than a binder and consequently the road will ravel. Again, we find oils which are not of uniform density and the bitumen will collect in spots and form a compact cake which causes the traffic to dig into the surface on either side of the hard spot. These spots make it very hard to drag the road properly, and are in themselves a detriment to easy riding. The worst enemy a sand-clay or gravel road has is extreme dry weather and the action of the oil tends to cause the metalling to dry out below the surface and a general loosening up takes place. A gravel or sand-clay road can be maintained to withstand reasonable traffic by frequent use of the drag and by adding additional material where needed to keep the cross-section true and free from depressions.

Waterbound Macadam

The principal thought which I have concerning waterbound macadam roads is not to build that type of road. However, waterbound macadam is far superior to mud, and if properly maintained will accommodate light traffic.

The maintenance of a waterbound macadam road must be constant and I think the patrol system is the best way of handling it. There is always a difference of opinion

concerning the mileage of road that one man can keep in repair, and as this depends to a great extent upon the particular road to be patrolled, it cannot be answered very definitely. I think a good average is five miles, and if the travel is not excessive one man, if capable and energetic, when supplied with the necessary equipment and materials, should be able to keep this mileage in good condition.

The abrasion on a road of this kind produces, as is well known, a large quantity of dust which is not only very unpleasant for the traveller, but is a part of the road itself, and if blown away leaves a space to be refilled. Various remedies have been tried, and while all of them have some merit, I do not think anyone can say what is the best thing to do. The use of the lighter road oils has given good results in some instances and poor results in others.

I think, however, an application at least once a year of a light road oil is very good practice in the maintenance of waterbound macadam roads, the amount of oil depending upon the amount the road material will readily absorb. I will not discuss the surface treatments of heavy oils and rock screenings, as I think this is adding a wearing surface and should not be considered when writing specifications for waterbound macadam.

Bituminous Roads—Penetration Method

The methods employed in repairing and maintaining this type of road depend upon the causes of failure. It is safe to say that a large percentage of the failure of penetration work is due to faulty subgrade construction. On account of the large percentage of voids in the base course, the upward pressure locally applied by frost action is very injurious to the surface.

In discussing the subgrade we encounter the old problem of drainage, and it would be practically impossible to maintain a bituminous surface if the soil of the subgrade was not thoroughly drained. Tile underdrains are well understood and for most types of surface will drain a heavy water-bearing soil in a satisfactory manner.

Penetration work gives the best results when laid over a permeable subsoil. Gravel or a mixture of sand and gravel are ideal subsoils. A heavy soil of low permeability is not a good soil for penetration work, but if the road is not subjected to extreme low temperatures, good results can be obtained by careful drainage, and by increasing the depth of the base course. Where the road is subjected to extreme low temperatures and the subsoil is of low permeability, it is advisable to place an insulating layer of gravel, or a mixture of sand and gravel, beneath the base course. Some authorities recommend that the insulating layer be composed entirely of sand, but I question the wisdom of this idea, owing to the fact that when a compacted layer of sand becomes saturated with water, then freezes, you have a rigid layer of material which will not contain much resilience.

In repairing the surface of a bituminous macadam road which has been carefully constructed with due regard to drainage, subgrade, size of stone, quality of binder and other construction details, you, as a rule, will find that the problem is either one of patching and evening up the surface to a true cross-section or, if the surface is too badly worn, a complete scarifying and re-surfacing becomes necessary. The work or patching consists in repairing sections of the surface which contain (*a*) spots of excess bituminous material, (*b*) bare or lean areas, (c) areas where the stone has become loosened and a series of potholes have been formed, (*d*) areas where the surface presents a wavy appearance, etc.

As a rule, the spots of excess material can be trimmed down and, if necessary, sealed with a light heated application of bituminous cement. The bare or lean areas, if ravelling has not commenced, may be sealed in a similar manner, care being taken to clean the surface thoroughly of any dirt or deleterious matter before the bituminous cement is applied. Where the surface has ravelled and formed holes, a more careful treatment becomes necessary. I think the most successful way of treating this problem is as follows:—

All disintegrated material should be removed and sufficient new material added to give the required depth, and the area sealed as in the original construction. The question of how to compact the added material is a much-discussed problem, but I am inclined to think that if the areas are small, it would be best to hand-tamp the new material, as it would be difficult to get the required compression with the roller, without injuring the edges of the sound surface. Where the surface presents a wavy appearance, it is a question whether it would be best to scarify and re-shape the surface, or to cut off the high places and re-seal, or, by cutting out the depression and replacing with new material. This can only be decided by close study of the problem in hand.

B.C. GOVERNMENT WILL COMPLETE PACIFIC GREAT EASTERN RAILWAY

Press dispatches from Vancouver say that the negotiations between the government of British Columbia and the Pacific Great Eastern Railway have been concluded and that the government is to take over and complete that railway. . The company is to pay the government $1,100,000, of which $750,000 will be in cash, and the balance after the war. The government will resume the operation of trains, which was recently suspended by the company, and will construct the line from Clinton to Williams Lake, a distance of 100 miles, during the present year.

The payment to the government releases the members of the company of their pledge to finish the line.

The decision was reached in a conference between Hon. John Oliver, provincial minister of railways, and R. C. Crombie, of the railway. No difficulty is expected in securing the necessary legislation.

The company hands over all its assets except the lands and holdings of the Pacific Great Eastern Development Company. The company is to pay the government $500,000 at once and $250,000 within four months. The remaining $350,000 may be paid at any time up to five years after the end of the war.

There are 37 mines under Provincial Government supervision, within a radius of 75 miles of Edmonton, Alberta. Of these 15 have trackage connection with the railways.

The University of Alberta gives the comparative value of Edmonton and Pennsylvania coal, expressed in B.T.U., as follows: Edmonton coals, 8,900 to 9,300; Pennsylvania, 12,800 to 14,800.

S. C. Charlesworth, Deputy Minister of Public Works, Alberta, stated before the recent convention of Local Improvement Districts and Municipal Districts that a system of 20,000 miles of good roads would mean a saving of $26,500,000, or about $1,000 a mile annually.

The Quebec Budget for 1917 shows payments to December 31st, under the Good Roads Act, 1912, of $15,571,548.18 from the authorized $20,000,000. Of this $5,656,388.20 went to government good roads. The estimate for Good Roads, 1918, is $400,000.

ROAD DEVELOPMENT IN ONTARIO*

By C. R. Wheelock
President, Ontario Good Roads Association.

THE roads of Old or South Ontario have developed from bush trails and portages to the present state. Traffic was originally confined to the waterways and gradually trails were opened up over portages between navigable streams and lakes. Food and material used by the natives and early settlers were carried over these trails. Year by year the main trails were extended and improved and eventually resulted in some of our main through highways, such as Dundas Street from Toronto to Dundas which was in early days the head of navigation for southwestern Ontario; that the Dundas road was laid out before any surveys were made is evident from the wandering route that it takes. Other examples may be found in the famous Talbot Road from Niagara Falls to Windsor, Hurontario Street and the Toronto and Sydenham Road from Port Credit to Owen Sound, and the Kingston Road running east from Toronto through Kingston, Cornwall and Prescott to the Quebec boundary.

As traffic increased, the trails were gradually widened and horses and carts introduced to provide transportation for heavier loads. It was then rendered necessary to make passable roads through the soft places in swamps and low-lying lands, and an attempt was made to pave such places with logs. The logs were of variable size laid on an uneven bottom, and the result was a most uneven surface. Many miles of this type of road were afterwards built, known as corduroy.

Many of the main through roads of the province were surveyed in the last decade of the eighteenth century. Dundas Street, to which I have previously referred, was surveyed about the year 1792, but was not bridged and fully completed for traffic until after the war of 1812, although the work of construction had been commenced some years previous to this time. This road adjoining Toronto may be taken as a concrete example of the development of our main roads. As stated before, it was originally a bush trail, afterwards surveyed and opened up as a main highway. The surface was built of broken stone and gravel. For years this had been added to as occasion demanded. Some years ago, to meet the increased traffic, a portion was resurfaced with waterbound macadam and a few years later the traffic became so intense it was necessary to apply a bituminous coating. A further increase in the volume of traffic has rendered that form of surface inadequate and last year a bituminous surface, known as asphaltic concrete, similar to that used on some of the well-known streets of Toronto, was constructed.

The first highway legislation of Upper Canada, enacted in 1793, authorized justices of the peace to be highway commissioners with overseers elected at parish meetings, who were under orders from the commissioners to repair roads, bridges and streets. It was also their duty to see that landowners fulfilled what had been known in England as "statute duty." This was the beginning of what is generally known as "statute labor," and under this system the most of the roads providing transportation for the early settlers were built and maintained. The statute labor law provided a means of opening up the original roads of this country when money was scarce and settlers few and far between, and although it was not without its limitations it solved most of the problems of land transportation for the greater part of last century. But the road laws that were suitable and worked out more or less satisfactorily in the province of Upper Canada in the nineteenth century are not suitable for the twentieth century conditions now surrounding transportation in the province of Ontario. The statute labor system has outgrown its usefulness. Township councils have been slow to acknowledge the disadvantages of this system for present-day road building and still cling to it at the sacrifice of good roads and economy, but many townships now appreciate the advantages of the later systems and as a consequence statute labor has been abolished in seventy-five of the most prosperous townships in the province. In thirty-five of these, road overseers have been appointed to take charge of the roads, as provided by the Ontario Highways Act, and 25 per cent. of the salaries of such overseers is paid by the government.

The old system in vogue had not been able to keep pace with the need for well-built post roads and about the year 1830, to meet this problem, toll companies were formed to finance this work. Thus the day of the toll-bridge and toll-road were ushered in. During the next twenty-five years many toll-bridges and toll-roads were built. The toll companies, whose duty it was to maintain the roads, were more inclined to pay dividends than to spend the money in making necessary repairs. Nothing was laid out on the roads that could be avoided; they were allowed to become in a deplorable state and were described as being an imposition upon the people and a great nuisance.

In 1874, county councils were authorized to take over township roads with exclusive jurisdiction over the same. Municipal councils could take toll to defray the expense of building or repairing plank, macadam or gravel roads. In 1889, an act was passed to facilitate the purchase of toll roads by municipalities. On roads so purchased all tolls were abolished and the roads maintained by the country. But until the Highway Improvement Act was passed in 1901 there had been no satisfactory solution of the toll-road question, a number of these roads were still in the hands of private companies, but have since been embodied in the county road systems assumed under the act.

The Highway Improvement Act was enacted after an agitation for improved roads carried on by the Good Roads Association.

The control of roads by the townships alone has not been satisfactory in building up an adequate system of public highways and there was for years a spirit of unrest in connection with the administration of the Statute Labor Law. A general agitation was commenced in favor of counties assuming the responsibility for the construction and maintenance of main market roads and for larger expenditures for highway improvement. This resulted in the organization of the Ontario Good Roads Association in 1894. A campaign of education was inaugurated. Farmers' Institute speakers were designated to introduce the question, and public meetings were held in different parts of the province. So numerous were the demands on the resources of the association that the government at its request in 1896, appointed a provincial instructor in road-making. This was the origin of the present Department of Public Highways in Ontario. As first created, it was a branch of the Department of Agriculture. In 1910 it had a staff of only three; since that year the growth has been more rapid, and in 1916 it was converted into a separate department under W. A. McLean, C.E., deputy minister, and has now a staff of about fifty employees.

The administration of the department covers provincial highways, county road subsidies, township road superin-

*Paper read before the annual meeting of the Association of Ontario Land Surveyors.

tendents, county and township bridge specifications, testing of road materials, and motor vehicles.

To meet the changing conditions and demands of the people, in 1901 the Highway Improvement Act, previously referred to, was passed, which, after being amended from time to time, was supplemented by the Ontario Highways Act in 1915-16 and the Provincial Highway Act in 1917.

The classification and description of roads under the above acts, taken from the department's last report, are as follow:—

County Roads. These roads are essentially the market roads—the farmers' roads. They radiate from market towns and shipping points, and meet the needs of accumulated farm traffic. The aiding of these market roads by the province is an effective means of assisting townships in their road improvement, in that township councils are thereby relieved from the burden of their most expensive roads, and can devote their energies to the improvement of less-travelled roads, comparatively inexpensive to maintain.

County roads are aided to the extent of 40 per cent. for construction and 20 per cent. for maintenance. All county councils are authorized under the Highway Improvement Act to assume and control a system of leading roads within the county.

Provincial County Roads. Co-operative with provincial roads, but under county control, certain roads may be designated by the Highways Department as "Provincial County Roads." To such roads the province will contribute 60 per cent. of the cost of construction and maintenance. These roads are intended to enable the more equitable maintenance of certain county roads, carrying a considerable portion of through traffic, but which the county may efficiently maintain, and which are not of sufficient importance to be classed as provincial, or which it is not desirable, or expedient, for the province to assume as provincial highways. They continue to be county roads, but because of heavy through traffic will receive an increased subsidy. In general, they will form branches of the provincial highway system, joining up cities and other important terminal points of traffic. They constitute an intermediate link between the provincial and county road systems, and may be subject to special regulation.

Suburban Roads. Provision is made under the Ontario Highways Act that a city may co-operate with the county council in improving the leading county roads adjacent to the city, and thereby obtain a more substantial type of construction for such suburban roads.

A commission is appointed to determine the roads and the length of each adjacent to the city to which the city would contribute.

For construction, the province contributes 40 per cent. and the county and city each 30 per cent.; for maintenance and repair, the province 20 per cent. and the county and city divide the remainder equally between them.

The section of county road designated as "suburban" remains a county road for which the county is responsible; the work of construction and maintenance to be carried on under the county road superintendent, but subject to the instructions of the special commission.

Provincial Highways. Described in the preamble to the act as: "A highway or system of highways from the south-western boundary of Ontario to the boundary line between Ontario and Quebec, together with highways connecting centres of population or other important terminal points."

The Lieutenant-Governor-in-Council, upon recommendation of the Minister, may designate any highway or a system of public highways through Ontario to be acquired, constructed, assumed, repaired, relocated, deviated, widened and maintained by the Minister of Ontario as a provincial highway.

Every provincial highway and all property acquired by Ontario under this act shall be vested in His Majesty and shall be under the control of the department.

The corporation of every municipality in which work of construction or repair and maintenance is from time to time carried out, shall repay to Ontario 30 per cent. of the expenditure made by the department within such municipality.

No part of the cost of surveys, of machinery, plant and equipment and the repair and maintenance thereof, all general overhead and staff expenses and salaries, and the cost of additional land or property for deviating, widening, or any other purposes of the department, shall be charged to the municipality, but shall be borne and carried by Ontario.

Up to the year 1916, only 20 counties had assumed systems of county roads as authorized under the Highway Improvement Act; now 34 counties out of the 37 in Old Ontario have adopted such systems and are proceeding with the work in a systematic manner under the regulations of the department. The total mileage covered by these roads is 8,427, and the total mileage constructed to date 2,275, the total approximate cost being $8,600,000, an average of $3,780 a mile. As the total mileage of rural roads in Old Ontario is 55,000, the mileage covered by county roads at the present time is 15 per cent. of the total. It is estimated by the Highway Department that 20 per cent. of the township roads, those usually included in a county system, carry 80 per cent. of the total farm traffic.

The county roads, when completed, will form an excellent system of market roads located in every part of the province. The provincial county roads will join up these county systems for through traffic and will merge the whole into a province-wide system reaching every county and town in the province, and to complete this system, trunk roads will be added, known as provincial highways, for trans-provincial traffic. This will create a system of provincial highways which will not have an equal in any province or state on this continent.

Road construction has been greatly retarded owing to war conditions, but, as stated above, over 2,000 miles of this system has already been built, the organization is complete, and the work will go ahead with leaps and bounds when the war is over.

In conclusion, a few words respecting road construction. The day for haphazard work by untrained men is past. The road problems of to-day require to be carefully worked out by the expert and the correct principles applied. A bridge is never designed without knowing the particulars as to loading, etc., and in the days of heavily loaded motor trucks it is also necessary, if we are to intelligently design our roads and get the best results, to take into consideration such particulars as the maximum load, width of vehicles, width of tires, nature of traffic, nature of sub-soil, etc.

The maximum load is the chief factor in determining the depth of foundation and a road built for light traffic may at certain times in the year have its surface broken up like pie crust by a heavily loaded truck.

The Ontario land surveyor has the technical qualifications, the training, and the experience to successfully carry on this work, and it would be in the interests of the public and himself to give this important branch of the profession more attention.

The Engineer's Library

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer, 62 Church Street, Toronto

The Calorific Power of Fuels. By Herman Poole, F.C.S. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Limited, Montreal. Third edition, re-written by Robert Thurston Kent, M.E. 267 pages, illustrated, 6x9 ins., cloth. Price, $3. (Reviewed by R. O. Wynne-Roberts, consulting engineer, Toronto.)

Fuel is undoubtedly the great and absorbing subject of the time, and the prospects of improvement in quantity and quality are somewhat remote, for even after peace is declared it will take months, at least, to enable the conditions to be readjusted.

Since 1898, when the first edition of this book was issued, many improvements in the use of coal, in the testing of its value, and in the efficiency of its consumption, together with the development of science in the production of new fuels, have taken place. And, moreover, tne information collected by careful studies, under practical conditions, afford an abundant scope for discussion. The fuel tests made by the United States Geological Survey and the United States Bureau of Mines, and the comprehensive and valuable reports issued, form the basis of the third edition of this book.

This volume is divided into eleven chapters and appendix. Chapters 2, 3, 4 and 5 deal with calorimeters and calorimetry. As the book was originally commenced as a translation of M. Scheurer-Kestner's "Pouvoir Calorifique des Combustibles," several of the calorimeters described are mainly European. Some well-known calorimeters are not mentioned, such as Parr's, Boys', and others.

Chapter 6 contains many tables giving data as to the analyses and value of coals found in the United States, Europe and elsewhere. Lignites are to be found in most countries. The writer had occasion in 1912 to investigate the lignite deposits in Saskatchewan and presented a report thereon to the provincial government. Consequently, any new information on this fuel was welcome, but my wish was not gratified to any appreciable extent, when perusing this book.

Peat is at present occupying considerable attention in parts of Canada. The author states that peat is partly decomposed and disintegrated vegetable matter that has accumulated in any place where the ordinary decay or decomposition of any material has been more or less suspended, although the form and a considerable part of the plant structure are more or less destroyed. It is formed by the agglomeration of vegetable debris and retains a large amount of water, which will not separate without heat. Its composition varies but little from that of wood, the principal difference being less oxygen and more carbon. The heat of combustion is lower than that of coal or lignite. The relative heating values of peat and other fuels are given as follows: Pennsylvania anthracite, 12,366 B.t.u.; Pittsburg bituminous coal, 13,365 B.t.u.; Texas lignite, 7,870 B.t.u.; Wisconsin brown peat, 7,468 B.t.u.

Brix obtained with peat an evaporative power of 5.11 lbs. of water.

Peat that is reduced to a powdered form has a larger percentage of volatile matter than coal, burns with a hot flame, and is well adapted for use in powder burners.

Seven pages are devoted to peat and four pages to wood fuel. Denatured alcohol may some day be a very important liquid fuel, especially as it can be produced with facility in Canada.

The appendix contains the code issued by the American Society of Mechanical Engineers relating to boiler tests, and eighteen tables.

The book will be found useful. It is well printed and written in plain terms.

PUBLICATIONS RECEIVED

Smithsonian Institution.—Annual report, 1916. Chas. D. Walcott, secretary, Washington, D.C.

Concrete Pressure Pipe.—Pamphlet published by Portland Cement Association, Chicago.

Existing Lake Levels.—Report of George M. Wisner, chief engineer, Sanitary District of Chicago.

Smith Gas Producers.—Illustrated catalogue published by the Smith Engineering Company, Lexington, Ohio.

The Ontario Bureau of Mines.—Report for 1917. Department of Lands, Forests and Mines, Toronto, Ont.

A Trip Through the Plant.—An illustrated pamphlet published by the Seybold Machine Co., Dayton, Ohio.

Ontario Provincial Board of Health.—Report for 1916. Published by Provincial Board of Health, Toronto, Ont.

Mines Branch of the Department of Mines.—Summary report for 1915. Published by Department of Mines, Ottawa, Ont.

Production of Cement, Lime, Clay Products, Etc., in Canada for 1916.—Mines Branch, Department of Mines, Ottawa, Ont.

Report of Minister of Public Works.—Report for the fiscal year ending March 31st, 1917. Department of Public Works, Ottawa, Ont.

American Society of Municipal Improvements.—Transactions for 1917-18. Published by Charles Carroll Brown, Secretary, Indianapolis, Indiana.

Dam and Water Power Development at Austin, Texas. Report by Daniel W. Meade. Published by the author and Charles V. Seastone, consulting engineers, Madison, Wisconsin.

Proceedings of American Institute of Electrical Engineers.—Published under the auspices of the Meetings and Papers Committee. Single copies, $1.

The Collapse of Short, Thin Tubes.—By A. P. Carman, Engineering Experiment Station, University of Illinois. Illustrated. Bulletin 99. Published by the University of Illinois, Urbana, Ill. Price, 20c.

Espanola District, Ontario.—By Terence T. Quirke. Memoir 102, Geological Survey, Canada, No. 85, Geo-

logical Series. Illustrations and geological maps. Published by Department of Mines, Canada.

Tide Levels and Datum Planes in Eastern Canada.—By W. Bell Dawson, M.A., D.Sc., M.Inst.C.E., F.R.S.C., superintendent of Tidal Surveys, Canada. Published by the Department of the Naval Service, Ottawa, Canada.

Tides at the Head of the Bay of Fundy.—Study of tide levels, compiled by W. Bell Dawson, M.A., D.Sc., F.R.S.C., M.Inst.C.E., superintendent of tidal surveys. Published by the Department of the Naval Service, Ottawa, Canada.

Conservation of Trade.—By Hon. Frederic Nicholls, chairman, special committee of the Senate of Canada on conservation of Canadian trade. Reprints and extracts from the debates of the Senate. Deals with trade conditions after the war.

Tests of Oxyacetylene Welded Joints in Steel Plates.—By Herbert F. Moore. Results of experiments testing strength of welds under (a) static load in tension, (b) repeated load (bending), and (c) impact in tension. Published by Engineering Experiment Station, University of Illinois, Urbana, Ill.

Road Material Surveys in 1915.—Memoir 99, Geological Survey of Canada, No. 82, Geological Series. By L. Reinecke. Deals with deposits of stone and gravel along a proposed Ottawa-Prescott highway in Ontario and road material available for a Hull-Grenville highway in Quebec. Illustrations and geological maps. Published by Department of Mines.

Power-driven Air Compressors.—The Canadian Ingersoll-Rand Co., Limited, Montreal, has recently issued Bulletin K-301-A, describing two-stage, power-driven air compressors of the duplex type. This is a 16-page pamphlet, outlining notable features of construction such as the "Circo" leaf valves, Haight 100 per cent. belt wheel joint, bath lubrication system, dust-proof frames and casing, compactness of design, accessibility of parts, etc.

COST OF WATER WASTAGE

In a report which he has just completed, City Engineer Mercier, of Montreal, shows in a striking and emphatic manner how costly are the unnecessary water-tap leaks. Universal metering of the service would tend to remedy all such leaks, as it would then prove more costly to the householders to neglect them than to repair them.

"A tap from which water is leaking drop by drop," says Mr. Mercier in his timely report, "loses 12 gallons of water in a day, which amounts to 84 gallons in a week and 4,368 gallons in a year. It costs 29 cents to pump the yearly wastage on one tap. For 1,000 taps so leaking, eleven tons of coal would be required and $290 in salaries.

"But the loss assumes graver proportions when the tap is one-thirty-second open. It spills 211 gallons a day, 1,178 a week, 76,876 a year. A thousand such taps require in a year 177 tons of coal to pump the water and $5,380 in salaries. Putting this loss in concrete terms, it may be thus estimated:

"Five cars of coal; or the salary of five constables; or the salary of five firemen; or the cost of paving 2,000 square yards of street, which represents the piece of St. James Street between St. Lawrence Boulevard and Place d'Armes. Further, it represents the cost of planting trees 25 feet apart on both sides of 1.2 miles of street, say, on Cote des Neiges Road from Sherbrooke Street to the entrance to the cemetery. It is as much as the city pays in a year to nine hospitals.

"It would buy 2,600 books for the civic library, and is equal in value to 10,760 gallons of milk, sufficient to feed 120 children.

The Serious Waste

"If the running tap is one-sixteenth open, the figures mount tremendously. Such a tap wastes 668 gallons a day, 4,676 gallons a week, or 243,152 gallons a year. A thousand such taps require for pumping 559 tons of coal and $17,020 in salaries. The waste equals 14 cars of coal, the wages of 17 policemen or firemen, and would pave St. Catherine Street from Metcalf Street to Phillips Square. It would plant trees in the manner above mentioned for four miles. It is as much as the civic grant in a year to 17 hospitals. It would buy 8,500 books for the library. It is as much in value as 34,050 gallons of milk, food for 372 babies.

Then, If Open More—Read!

"If the tap is turned on one-eighth, the wastage of water becomes still more alarming. It reaches 2,330 gallons per day, 13,612 gallons per week, or 811,865 gallons per year. To pump this amount for 1,000 taps demands 1,868 tons of coal, and costs $56,811 in salaries. The loss represents 47 tons of coal, the wages of 56 police or firemen, the paving of 18,000 square yards of street. It would plant with trees twelve miles of street. It would represent city grants to 17 hospitals, six dispensaries, nine homes for the aged or children, six refuges, and 34 miscellaneous institutions. It would buy 28,400 books for the library, or buy 113,622 gallons of milk, enough to feed 1,244 children for a year.

"Turned on one-quarter, that wasteful tap would lose 7,632 gallons per hour, 53,222 per week, 2,767,564 per year, a pumpage that would require 6,336 tons of coal, and cost $193,729 in wages.

"If turned on full, the amount of water wasted would be 20,160 gallons per hour, 131,120 per week, and 7,338,240 gallons a year. This, estimated on the 1,000-tap basis, would consume 16,877 tons of coal in pumping, and cost $573,677 in salaries."

TYPHOID IN TORONTO

Chlorination of the water supply and inspection of milk supplies are reducing the typhoid death rate more and more every year in the city of Toronto. "In 1917 there were only 95 cases in the city, with the extremely low death rate of 3.8 per 100,000 of population," says a recent bulletin issued by the Toronto Department of Public Health. "There are so few cases of this disease in the city hospitals that it is difficult for students in the medical faculty to obtain a sufficient number of cases for examination and study purposes.

"There is not one case of typhoid per annum for each four physicians in Toronto, so that many physicians never see a single example from one year's end to the other.

"When it is considered that we had 739 cases of typhoid fever reported in the year that the present health department organization began its labors, one can realize how much the general health of the city has improved, for the number of cases of typhoid fever is considered to be the best single criterion of the healthfulness of a city."

Letters to the Editor

Provincial Consulting Engineering

Sir,—I have read the interesting article by Mr. R. O. Wynne-Roberts in your issue of February 14th and I would like to say at once that in referring to his objection to the proposal I put forward at the Hamilton conference, that we should have more skilled engineering advice in provincial authorities, I had no idea of suggesting that his objection was not well founded. Indeed, since I have conferred with several engineers on this matter I find there is good ground for the objections which they put forward to engineering advice being provided through the agency of government departments. Their objection, however, is not to the principle of such advice being given but to the possible evils which may arise in connection with giving it. For instance, it is contended that when engineers are attached to government departments they sometimes exercise the dual function of supervising the work of local authorities and of designing and carrying out the work themselves. It never occurred to me that this kind of thing was done to any very large extent and I admit that if it were to be a regular practice in connection with government engineering, I should entirely oppose any suggestion to create more official engineers or improve their status. In my judgment, an engineer who is employed by any government authority as a salaried official should not only be prevented from undertaking constructive private work himself, but should be made to feel that it is most improper to do so. Of course, it is essential that official engineers should be paid a sufficient salary to make them independent of private work. The point, however, is that any advocacy I have made to increase the number of provincial and municipal engineers is based on the assumption that they would not be permitted to do private work and that their functions would be largely of a judicial character.

In regard to the second objection which Mr. Wynne-Roberts raises in his letter, I admit the soundness of his contention that men who are paid by the government should not be permitted to take the bread out of the mouths of those who are engaged in private practice as a general rule. There are exceptions, however, and I think Mr. Wynne-Roberts himself agrees that no hard and fast rule can be laid down in this respect.

It will be noticed that I deliberately used the term "small municipalities" when I suggested that advice and assistance should be given. These small municipalities cannot employ skilled consultants and until they can, there is no objection to giving them advice through the provincial government. On the other hand, when larger municipalities are able to employ skilled engineers the presence, in the provincial government, of a department of municipal affairs would be a great stimulus to local authorities to employ proper engineering assistance.

I do not think that any engineering advice and assistance given by the government should be other than gratuitous but it should only be given where a local authority has inadequate means to employ an engineer. In other cases the function of the department would be to encourage the use of engineers in private practice. I am aware that there is the difficulty of not being able to draw the line, but we had to meet exactly the same kind of circumstances in connection with town planning in England and we succeeded because we always erred on the safe side by not giving advice or assistance except in very necessary cases. As Mr. Wynne-Roberts says, the function of the government engineer in England is primarily judicial, and it will only be necessary for it to be advisory in Canada while we are waiting for improved status for the engineer and while we are trying to get rid of our present low standards of sanitation in some municipal areas.

I am grateful to Mr. Wynne-Roberts for the generous way in which he deals with my suggestions. With him I would like to see the engineers themselves more persistent in demanding a better recognition of their skill and executive ability.

I have the utmost respect for members of the legal profession, but when one hears it so frequently reiterated that engineers have no judicial or executive ability and, therefore, that lawyers only are fitted to become members of judicial or executive bodies, it makes one feel that engineers must be without an agency to adequately represent them collectively in securing proper recognition of the profession.

Only recently we have seen engineers made heads of great trunk railways, of the food department of the United States and of some of the chief administrative departments of Great Britain. We are told that among the most successful executive heads of the intelligence branch of the British army is a man who was a consulting engineer in Toronto up to the outbreak of the war. When we look round and see the position which the engineer takes as an executive and in a judicial capacity when the opportunity is provided for him, one can only lament the fact that that opportunity is so wanting in Canada and feel that the engineers themselves must be partly to blame. At any rate it is certain that improvement will only come if the engineers take the initiative and if they be loyal to one another in insisting upon every member of the organized profession practising up to an ethical standard equal to that of any of the great professional institutes in other countries.

THOMAS ADAMS,
Town Planning Adviser,
Commission of Conservation.

Ottawa, Ont., February 22nd, 1918.

Quebec Bridge Main Shoes

Sir,—Referring to the article on expansion joints and traction trusses, Quebec Bridge, appearing in your issue of February 7th, 1918, the contents of the concluding paragraph of this article might leave the impression on the reader's mind that the main shoes were not placed on the centre line of the main piers.

As a matter of fact, inasmuch as the final alignment of the whole structure from shore to shore depended on the placing of the main shoes, these shoes were set with exceptional accuracy and on the centre line of the main piers.

The deviation of 3 inches from the theoretical span of 1,800 feet is in the final distance centre to centre of main piers. As stated in the article, a total allowance of 4 inches was made in the expansion joints between the cantilever arm and suspended span to take care of a possible error of this kind.

A. J. MEYERS,
Chief Draftsman,
Board of Engineers, Quebec Bridge.

Montreal, P.Q., February 12th, 1918.

EXPANSION OF MINERAL INDUSTRY ESSENTIAL

Canada pays more money for imported mineral products than she receives from her mines, the commission of conservation reminds us. The value of the mineral production for the calendar years 1913, 1914 and 1915 was $145,600,000, $128,865,000 and $137,100,000 respectively. The imports of products of the mine and manufactures of mine products for the same years were valued at $259,300,000, $181,676,000 and $146,324,000. As the imports also include manufactured, or partly manufactured products, they are much more valuable than the minerals we produce. If, however, Canadian minerals were turned into manufactured products in Canada, the present trade balance in minerals would be reversed.

It is only fair, though, to point out that Canada is under serious disadvantages in the matter of manufacturing. The relatively small and scattered population makes distribution from points of production to points of consumption both difficult and costly. Similarly, where, for example, coal is essential for reducing ore and for manufacturing, the cost of transportation necessary to bring the two raw products together, bears heavily on manufacture. Copper, zinc and lead are produced principally in Western Canada, while the manufacturers and chief markets are in eastern Canada. In spite of these handicaps, a comparison of the figures for imports and those for production shows the opportunity that exists for developing a home market that will increase as the war goes on. Premier Lloyd George in his recent address stated that "Economic conditions at the end of the war will be in the highest degree difficult. . . . There must follow a world shortage of raw materials, which will increase the longer the war lasts, and it is inevitable that those countries which have control of raw materials will desire to help themselves and their friends first."

The mineral resources of Canada, if developed, could supply not only our own needs but also permit the exportation of a surplus to other parts of the British Empire. There is, in Canada, an urgent need for production to pay for our war debt and borrowings before the war, and if we are to get the greatest value out of our mineral industry it is necessary that our metals and minerals be refined and made into manufactured or partly manufactured products in Canada. The production of certain mineral products in Canada has been stimulated by the war and new industries created. In the period of reconstruction, after the war, it will be necessary to safeguard and provide for the further extension of these industries.—From "Conservation."

THE EXPERIMENTAL PLANT AND SANITARY ENGINEERING SERVICE

"At the Experimental Plant of the Provincial Board of Health problems arising in connection with sewage disposal and purification of public water supplies are studied. Units of appliances, such as mechanical slow sand filters, sewage tanks, sludge plants, etc., are established and their capacities and values tried out. In this way the Board through the Engineer is able to offer expert advice to municipalities proposing to erect a water purification plant or a sewage disposal works. For all of these works plans, specifications and an engineer's report are required by law to be presented for approval of the Board. If the plans are faulty, too expensive, inadequate or unsuitable for the work in hand they are checked up by the Board's Engineer and the municipality is often saved considerable unnecessary expense and trouble.

"The volume of work of this character is bound to become very extensive in Ontario. In a recent year upwards of four million dollars' worth of work of this character passed through the hands of the Board."—Public Service Bulletin, Province of Ontario.

A vertical water turbine which tested at 94.5% efficiency, has been installed at Copper Cliff, Ont., for the International Nickel Co., by Henry Holgate, consulting engineer, Montreal. The unit delivers about 9,000 h.p., operating under 85-ft. head.

The quantity of cement imported into Canada from the United States is being reduced yearly. In 1913, there were imported 986,464 barrels; 1914, 88,591 barrels; 1915, 51,240 barrels; 1916, 19,692 barrels. The value of the 1913 importations was $1,580,506, and of the 1916 importations, $31,067, showing a reduction of over one and a half million dollars.

RECEIVER FOR CENTRAL RAILWAY

Judgment has been rendered by Sir Walter Cassels, sitting in the exchequer court, Montreal, rejecting the petition of the directors of the Central Railway Company of Canada for confirmation of a scheme of arrangement between that company and its creditors. Immediately following the rejection of the scheme of arrangement an application was made by John W. Cook, K.C., counsel for the City Safe Deposit and Agency Company, Limited, of London, England, who are trustees for the bondholders, asking for the appointment of F. Stuart Williamson, of Montreal, as receiver. This application was made in a suit taken by the trustees, which has been pending for some time. The application was granted and Mr. Williamson was sworn in as receiver.

These judgments are the culmination of various legal proceedings in the exchequer court concerning the affairs of the Central Railway Company, of which C. N. Armstrong is president, having succeeded to this office upon the death of the late Senator Owens.

The other directors of the railway are W. D. Hogg, K.C., E. A. D. Morgan, J. T. Bethune, J. O. Dupuis and J. D. Wells, the latter having also acted as secretary of the company. Apart from certain subsidiary roads, it was intended that the main line of the Central Railway should run from Montreal to Midland, but only twenty miles have been partially constructed. Bonds to the value of more than £427,000 have been issued, these being largely held in England and France. These bonds do not seem to have been highly regarded by the Canadian investing public.

A SOURCE OF TOLUOL

There is an almost untapped supply of toluol, the basis for T.N.T., in the form of a waste product of a sulphite pulp mill. This waste material is the spruce turpentine which can be collected during the cooking in a simple apparatus whose cost is estimated at less than $100. The collection of the spruce turpentine is simple and the material can be shipped for refining to a central point by means of drums, tank cars or barrels. If any acid reaction is found after collection this may be neutralized with lime, but care in collection will eliminate this difficulty. It is probable that the crude turpentine can easily stand a shipment of requiring 14 days in transit. A refining plant handling 500 gallons per day of the crude material is about the smallest commercial unit. At present prices for toluol, $5 per barrel for the crude material might be obtained. Experiments and estimates as well as actual practice have shown that one gallon of crude turpentine per cord of wood is not an impossible yield. The yield, however, varies with a number of factors, such as, the kind of wood, its age and condition, method of cooking and the process of collection. A plant in New Jersey is making 1,000 gallons of toluol a week now and could make much more if the spruce turpentine were available.—Exchange.

NEW SHIPBUILDING ENTERPRISES

A number of representative citizens of Sault Ste. Marie called upon Sir William Hearst, premier of Ontario, recently to discuss with him plans for establishing a shipbuilding industry at Sault Ste. Marie. Before the war steps were taken to establish a shipbuilding plant and drydock, but work has been delayed. Now it is proposed to begin the construction of wooden ships in connection with the steel plant, with a view to steel-ship construction later.

The British Columbia shipbuilding programme is to be augmented by the construction of forty wooden ships, aggregating a total of 140,000 tons. Twenty of these ships will be built in Victoria by a syndicate of capitalists, headed by J. G. Price, president of the Cameron-Genoa Mills Shipbuilding, Limited, the new shipbuilding concern to be known as the Victoria Shipbuilding, Limited, while the remainder will be built by the British-American Shipbuilding and Engineering Company, Limited, which had secured the lease of a shipbuilding site on the old Kitsilano Indian reserve at Vancouver. The larger company is headed by J. A. Sears, of Vancouver.

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Principal Contents of this Issue

EARLY STREET CLEANING

Muddy streets, although a nuisance to pedestrians, are in one way beneficial to public health. The amount of street dust which must be breathed by the populace is greatly reduced when the streets are wet and muddy late in the winter. When the streets dry after the first spring thaws, and too early for the summer sprinkling carts and flushers to get into action, there is always a great increase in the amount of general sickness prevailing in cities.

Many physicians formerly attributed this prevalence of ill-health during early spring to the fact that one's constitution was likely to have been weakened by the strain of having withstood a whole winter of severe cold weather. This theory has been gradually abandoned and most physicians now attribute a large portion of the spring ailments to street dusts.

The dread power of street dusts is well known. Scores of the most virulent germs find their habitat in such dust. Out of forty-six inoculations into animals by Dr. Concornotti, with bacteria from city dust, thirty-two caused infectious diseases (*vide* "Bacteria in Daily Life," G. C. T. Frankland, London, 1903, p. 216).

B. tuberculosis, B. coli. comm., the bacterium pneumococcus, staphylococcus and streptococcus, pyogeneus, diphtheria, anthrax and tetanus, have been recognized as permanent inhabitants of dust (*vide* "Quantitative Study of the Bacteria in City Dust," Winslow and Kligler, American Journal of Public Health, Vol. 2, New York, 1902, pp. 663-701; and "Street Dust as a Factor in Spreading Disease," Anders, Medical Record, Vol. 78, New York, 1910, pp. 563-6).

Tonsilitis, quinsy, laryngitis, pneumonia, influenza, tuberculosis, asthma, rheumatism, diarrhoea, skin disease, conjunctivitis, trauma of the cornea, nasal catarrh, frontal sinus affection and middle ear disease from irritation of eustachian tubes,—all these lurk in the dust of the streets; chronic catarrhal colds and augmentation of the adenoid growths frequently are due to irritation and infection by street dust (*vide* "Dust Menace and Municipal Disease," Anders, Journal of the American Medical Association, Vol. 57, Chicago, 1911, pp. 1524-6).

Moreover, dust may, by predisposing an irritated condition of the respiratory organs, so lower the vitality of the mucosa that the development of any germ deposited thereon will be favored (*vide* "Dust and Its Danger to Children," La Fetra, Archives of Pediatrics, Vol. 23, New York, 1906, pp. 869-72).

A very alarming relation between dust and disease is revealed in the fact that experiments show dust-carried infection of infantile paralysis (*vide* "Experimental Poliomyelitis," Neustaedter and Thro, New York Medical Journal, Vol. 94, New York, 1911, pp. 613-5 and 813-20).

To sum up, suspicion points to street dust as one of the worst etiological mischief makers. City and town engineers who value the health of their public will begin the thorough sprinkling and flushing of streets at the earliest date permitted by the weather. There should not be the unnecessary delay that has occurred in past years in many Canadian municipalities.

ELECTRIFICATION OF RAILWAYS

Replying to a delegation which called upon the government at Ottawa last week urging the electrification of the Ontario lines of the Grand Trunk Railway, Premier Borden said in part: "I suppose it is a more or less technical question. I can see that we are in a different position to many countries and that we can succeed more quickly along such lines than in the United States, but you will agree that there is no use of our embarking on such proposals without seeing whether we are on the right track."

There can be no question but that Canada does occupy an enviable position so far as the electrification of her railroads is concerned, blessed as she is with a most valuable heritage of developed and undeveloped water powers. We should be in a position to tackle this problem with considerable confidence and excellent prospects of success. The day ought not to be far distant when Ontario's stores of electrical energy might be applied in channels where they are most needed.

Electrification of railways in Ontario would mean the releasing of vast quantities of coal which could be used more advantageously for heating purposes.

Speaking before the annual meeting of the American Institute of Electric Engineers a few days ago, E. W. Rice, Jr., president of that body, declared that ten per cent. of the ton mileage of the railways in the United States is taken up in moving coal, and as most of the coal is used by railways, they are stumbling over themselves by clinging to steam power. He furthermore stated that electrification of railways of the United States would save about a hundred million tons of coal annually.

If more of our railroads which are now operated by steam engines using coal as fuel, were driven by electrical power, hydraulically generated, it would mean that many of our water powers hitherto undeveloped would be harnessed for useful work. As every undeveloped water power is to all intents a burning coal mine (for coal of equivalent power would be saved if the water power were utilized), to that extent the exhaustion of the coal supply would be postponed.

PERSONALS

Capt. LEROY Z. WILSON, of Brampton, Ont., B.A.Sc. '09 University of Toronto, has been awarded the Military Cross.

EUGENE McG. QUIRK, A.Can.Soc.C.E., of Montreal, has been appointed to the Canada Registration Board of the War Committee.

JAMES HUNTER, formerly of the Hunter Structural Steel Co., Toronto, has received an appointment as structural engineer with the Marine Boat Corporation, New York.

J. G. SEYFRIED, formerly structural engineer with the bridge department of Canadian Allis-Chalmers, Limited, Toronto, has joined the Lackawanna Steel Company, Buffalo, as structural engineer.

ROSS H. McMASTER, the assistant general manager of the Steel Company of Canada, has been appointed to the staff of the Canadian War Mission to Washington. He will be purchasing agent for the iron and steel industries.

J. J. SCOLLOM, formerly general superintendent of the Davenport Works of Canadian Allis-Chalmers, Limited, Toronto, and latterly manager of that firm's shipyard at Bridgeburg, Ont., has been appointed manager of hull construction for the Marine Boat Corporation, of New York.

FREDERICK H. PETERS, commissioner of irrigation and chief engineer of the Department of the Interior, Calgary, Ont., addressed the Ottawa Branch of the Canadian Society of Civil Engineers on Thursday last upon "Ways and Means for Improving and Defining the Status of the Engineer."

THOMAS LEES, A.M.Can.Soc.C.E., formerly resident engineer for the Canadian Pacific Railway at Calgary, Alta., has been appointed engineer of water services at headquarters at Winnipeg. R. C. HARRIS, formerly of Edmonton, will succeed him and will be replaced by H. H. TRIPP, of Kenora, Ont.

J. F. RHODES, A.M.Can.Soc.C.E., publicity manager of the Canada Cement Co., Limited, has resigned to accept a position with the Trussed Concrete Steel Co., at Youngstown, Ohio. Mr. Rhodes came to Canada about four years ago after having been in the employ of the Grasselli Chemical Co. as designing engineer. He is a graduate of the University of Pennsylvania.

A. P. S. GLASSCO, B.Sc., A.M.Can.Soc.C.E., has been appointed secretary and bursar of McGill University, in succession to W. Vaughan, retired. Mr. Glassco graduated in engineering at McGill in 1901, and later was appointed assistant bridge engineer of the G.T.P. From 1905 to 1908 Mr. Glassco was assistant engineer of the Quebec Bridge Commission and afterwards assistant manager of the Cleveland Bridge Company. Subsequently he was a member of the engineering firm of Atkinson, Glassco & Lawrence, Montreal.

OBITUARIES

JOHN J. MOLLOY died at Winnipeg on February 19th. He was born at Guelph, Ont., in 1837, going west in 1872 as resident engineer of the C.P.R., construction of which was then just starting. He left the C.P.R. in 1897 to take charge of Dominion government surveys. He retired from public life in 1917. Mr. Molloy represented Provencher in the Manitoba House for several years.

CAN. SOC. C.E., OTTAWA BRANCH

John Blizard, A.M.Can.Soc.C.E., will present a paper before the Ottawa Branch, Canadian Society of Civil Engineers, this evening on "Availability of Energy as a Source of Power and Heat." Mr. Blizard will deal with his subject from the standpoint of the power and fuel requirements of the Dominion.

CAN. SOC. C.E., MONTREAL BRANCH

Philips B. Motley, engineer of bridges, Canadian Pacific Railway, will read a paper to the members of Montreal Branch, Canadian Society of Civil Engineers, this evening on "Tests of Chain Guards on the Panama Canal." Henry Goldmark, M.Can.Soc.C.E., who wrote the paper, will not be able to be present, so Mr. Motley has consented to read it for him. The paper will be illustrated by lantern slides.

CAN. SOC. C.E., TORONTO BRANCH

A meeting of the branch is to be held in the Chemistry and Mining Building at the head of McCaul Street on Tuesday, March 5th.

President H. H. Vaughan and Secretary F. S. Keith of the Canadian Society of Civil Engineers will be present to place before the branch the possible activities of the society under the new by-laws passed at the recent annual meeting.

A.I.E.E., TORONTO BRANCH

The following program has been arranged by the Toronto Branch of the American Institute of Electrical Engineers for the month of March:—

Friday, March 1st, at Engineers' Club, 96 King Street West, at 8 p.m., N. P. Jackson, of the Research Division, Westinghouse Electric and Manufacturing Co., Pittsburgh, will read a paper on "Commercial and Industrial Research."

Friday, March 8th, is the date of the Institute meeting at Cleveland, Ohio, in which the Toronto section is participating as a host.

Friday, March 15th, at Engineers' Club, 8 p.m., J. J. Frank, of the General Electric Co., Pittsfield, Mass., will read a paper on "Recent Developments in Transformer Practice."

The mine operators at Kirkland Lake, Northern Ontario, propose to have a comprehensive survey made of the geological structure of that district.

B. F. Haanel, B.Sc., Chief of Fuels and Fuel Testing Division, Department of Mines, Ottawa, addressed the members of the Toronto Board of Trade to-day on "Peat."

Through contracts placed by the British Government direct, British Columbia's shipbuilding programme is to be augmented by the construction of forty wooden ships, aggregating a total tonnage of 140,000.

W. G. Clarke, Thos. Cantley, Percy Black, Jas. Kelleher and Walter Crowe have been appointed members of the newly-formed Nova Scotia Provincial Highways Board. W. G. Clarke, of Bear River, N.S., is chairman.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Elimination of Grade Crossings

Relative Advantages of Cuts and Embankments—Each Crossing Calls for Special Study—Paper Read at Conference of County Road Superintendents

By E. R. BLACKWELL, A.M.Can.Soc.C.E.
County Engineer, Leeds and Grenville Counties, Ontario

GRADE crossings of railways have become such a prolific source of accidents since the advent of automobiles, that their elimination is a problem which must be solved.

The chief difficulty to overcome is the cost, and in a great many cases this is so excessive as to be almost prohibitive.

In Canada, the matter is almost altogether in the hands of the Board of Railway Commissioners, who have the power to order such changes or alterations as they may deem advisable and to assess the cost thereof to the railway and municipality benefited.

A petition from any municipality, or from the residents of a district interested, for the protection of a grade crossing will be considered and passed upon by the Board.

The writer had the privilege of appearing before the commissioners on two occasions; the first was in connection with a grade crossing at Lansdowne, on the Grand Trunk Railway, and in this instance an order was given to place a flagman on the crossing, the cost to be paid by the railway and the local municipality in the ratio of 75 per cent. and 25 per cent. A subway at this point would be very expensive on account of a steep hill paralleling the railway.

On the next occasion, an order was given for a subway on the main line of the Grand Trunk, and for about three-

A Dangerous Subway

quarters of a mile of road diversion, which eliminates two other crossings. This is on a county road about three miles west of the town of Brockville. The cost was assessed to the railway, subway fund, township and county, in the ratio of 50, 20, 15 and 15 per cent.

In the State of Vermont the railways are required to eliminate one grade crossing each year, and as the crossing is not specified, naturally the railways have built the less costly first, irrespective of the conditions of the crossings and the traffic, so that now they are encountering very expensive construction.

As regards the elimination of individual grade crossings, the topography of the location generally decides as

The Sharp Turn Makes This Subway Dangerous

to the method of separation. For instance, if there were a grade crossing in a railway cut at the present time, and it were required to eliminate same, the natural sequence would be to carry the highway over the railway by a bridge; or under the railway by a subway if the railway were built on an embankment.

As to cost, it is impossible to give any definite figure and say that same will apply to all crossings. For instance, the unit prices of the various materials entering into construction of grade separation varies with the locality and the prevailing wages in that district; also transportation for both men and materials. Therefore, each crossing is a special case by itself and should be so studied.

As regards grade separation in the cities and towns, the topographical features still control, but as a rule separation never takes place until some time after the railway has been in operation, and then the entire territory is considered as a whole and the grade line of the railway revised. In the majority of cases the grade line is generally laid so that the railway will be elevated approxi-

mately 10 feet above the ground and the streets depressed from 8 to 10 feet, or a sufficient amount so that the excavation from the streets will make up the embankment for the railway between the streets.

This adjustment of grade line is an economic one from the standpoint of cost, and if the grade of ramps does not exceed 3 or 4 per cent. in 100, one can have a clear view under the railway bridge if driving a team or automobile.

This was the method adopted in the case of the subway built on road No. 49 of the county system of Leeds and Grenville, in the township of Edwardsburg. The railway embankment was raised some nine feet, enabling the roadway to pass under with little or no depression. This method was also adopted by the Grand Trunk Railway in the city of Detroit where grade separation has been going on for the last 15 years.

The Grand Trunk Railway, in making studies for grade separation in the city of Detroit, was able to prove that, if the railway were carried on embankment from Brush Street Station to the top of the bench north of Gratiot Avenue, it would be much cheaper than the plan suggested by the city for depressing the railway tracks and carrying the streets over the tracks.

It has generally been found in considering the question of grade separation that, as a rule, the economic proposition is to place the grade line of the railway on embankment, although, as I have said before, the topographical features will rule.

As regards the minimum clearance of bridges over streets and highways in grade separation in the United States and Canada, the individual States vary in their requirements. For instance, in Buffalo the minimum clearance is 13 feet and on street car lines, 14 feet; in Chicago, 12 feet, and 13.5 feet on car lines; Detroit, 13 feet, and 14 feet on car lines; New York, 14 feet; Philadelphia, 14 feet; Vermont, 13 feet; and Canada, 14 feet.

The maximum grade laid for street ramps in the United States, varies in the different States and cities from 3 to 5 per cent., but there have been exceptions to this in special

Typical Level Crossing

cases, on account of location, where the grade has been 9 and even 10 per cent. In Canada, the Board of Railway Commissioners have control of grades and location.

In the province of Ontario, where the highway passes over a railway by a bridge, the clear distance between the top of rail and the lowest member of the bridge is specified in chapter 185, section 116, clause 1 of the Revised Statutes of Ontario, which reads: "Every bridge, tunnel or other erection or structure, over, through or under which any railway passes, shall be so constructed and maintained as to afford at all times an open and clear headway of at least seven feet between the top of the highest freight car used on the railway and the lowest beam, member, or portion of that part of such bridge, tunnel, erection or structure, which is directly over the space liable to be traversed by such car in passing thereunder."

Approaches to subways should be laid out so as to get as clear a view as possible and in no case should this be

Unusual Growth on Right of Roadway Makes This Crossing More Dangerous

less than 100 feet, and if the topographical features are such that this cannot be had, then a "slow order by-law" should be passed, and large signs, readily seen, placed on the road.

The drainage of subways is a very important matter and when the roadway is depressed to any extent, may be very difficult and expensive, and in certain cases impossible.

When drainage cannot be had, pumping has to be resorted to, in which case a well is constructed and a pumping system installed.

As an instance of expensive drainage, I might mention the Thompson Road subway at Fort Erie yard, Bridgeburg. This subway is under 15 tracks and cost approximately $90,000. A deep drain had to be excavated to the nearest creek, a distance of about one-quarter of a mile, and rock was encountered which cost about $5 per yard to remove.

WATERPROOFING FOR CONCRETE BOAT

The entire hull of the concrete boat built last fall at Montreal was coated with Toch Bros.' "Liquid Konkerit" waterproof cement coating. All of the hull below the water line was given a second coat, using Toch Bros.' R.I.W. 112, which is especially made for coating hulls of ships below water lines.

BRITISH COLUMBIA ENGINEERS

The Kootenay branch of the Engineering and Technical Institute of British Columbia was formed at a recent meeting in Nelson, B.C., the headquarters of the branch.

The institute, which is applying to the legislature at the forthcoming session for a charter, will be an organization composed of civil and mining engineers, architects and members of allied professions.

The following provisional officers were appointed: Wm. Cunliffe, chairman; A. E. Pickford, secretary-treasurer, and A. E. Thompson, assistant secretary-treasurer.

DISCUSSION OF ENGINEER'S STATUS

At a special meeting of the Ottawa Branch of the Canadian Society of Civil Engineers on February 22nd, the subject of "Ways and Means for Improving and Defining the Status of the Engineer" was discussed. F. H. Peters, commissioner of irrigation, Department of the Interior, Calgary, introduced the discussion, outlining the action with respect to legislation which was contemplated by the Calgary Branch and the events which had led to the drafting of the following resolution of that body:—

"Resolved by the Calgary Branch of the Canadian Society of Civil Engineers, at their annual general meeting, held December 1st, 1917:

"That it is desirable at this time for the membership of the society to discuss the advisability of seeking Dominion legislation which shall define the status of the engineer to the end that the profession and the public may be adequately protected against the practice of the profession by unqualified persons.

"That the secretary of the society be requested to take the necessary steps to procure discussion on this matter within all the branches of the society; to obtain a definite expression of opinion from all the branches; and in due course to report to council and to all the branches, the consensus of opinion expressed.

"That with a view to facilitating discussion within the various branches, a report be attached to this resolution, indicating the evolution of this matter within the Calgary branch and suggesting the lines along which suitable legislation may be framed.

"That copies of this resolution be sent to the council, to all the branches and to *The Canadian Engineer*."

The speaker said that this action had been contemplated not only that the engineer might be accorded the standing and the recognition in the community which by virtue of his profession he deserved, but also that the public might be protected against the practice of the profession by unqualified persons.

R. deB. Corriveau approved of the resolution of the Calgary branch and suggested that members in each province should be encouraged to secure action from the provincial legislatures to define the status of the engineer. He announced the receipt of a message from A. R. Decary, of Quebec, regretting that matters had prevented him from coming to Ottawa, and read a communication from Mr. Decary explaining the amendments to the Quebec Act defining the status of the practice of engineering, made at a recent meeting of the Quebec Legislature. This communication suggested that definite arrangements be made for holding in Montreal a meeting of representatives of the society from all the provinces with a view to considering ways and means for securing suitable action to define the status of the engineer in the near future.

A. A. Dion referred to the past attempts to secure legislation in Ontario and to the opposition from the Amalgamated Society of Engineers. He pointed out that there is serious objection to Dominion legislation, because the British North America Act places authority in the premises in the provincial legislature. With reference to the measure of control which is necessary to remove the objection that too much power would be given to the society itself, there was the question whether it should be left to the universities, a government board, or some other body. He thought that any action found advisable should not be confined to civil engineers, even if by doing so it would be possible to draw in other branches of the profession.

B. H. Fraser pointed out that, while there is objection to separate laws and regulations, this may be overcome through the society, which is Dominion-wide. Duncan MacPherson agreed with the general proposals of the Calgary branch, but thought that as the society is in a state of flux, it would be well to make haste slowly.

John Murphy favored legislation but recommended that the legislation be made by electing members to the House. A. A. Dion, speaking later, referred to a proposal made by prominent politicians to an engineer, that there should be created a general engineering constituency which would elect one member to every parliament.

Col. Anderson suggested that one important move would be effected if the government were asked to change the Civil Service Act to provide that the government must employ only qualified engineers; that is, members of the Canadian Society of Civil Engineers or graduates of some recognized engineering school.

A. F. Macallum, J. E. N. Cauchon and R. R. Smart also spoke in favor of legislation. W. J. Dick and R. F. Uniacke advised caution and discussion.

James White did not agree with the Calgary branch proposals because of the difficulty of obtaining effective legislation. He told how hard it had been to obtain laws for the protection of game birds in migration, adding that if the Dominion would not legislate for a flock of ducks, there was no hope for the engineers! However, he expressed very warm appreciation of the work of the Calgary branch in developing their ideas in this very important matter and voiced his determination to do everything in his power to help advance the engineering profession.

R. R. Smart thought that it might be possible to obtain Dominion legislation to prohibit the promiscuous use of the degree letters, C.E., M.E., etc.

A resolution commending the action of the Calgary branch was passed unanimously by the meeting, and a committee was appointed to make a further report on the matters brought out in the discussion. The members of the committee are Messrs. Smart, Corriveau, Dick, Gale and Challies.

ONTARIO GOOD ROADS CONVENTION

The sixteenth annual meeting of the Ontario Good Roads Association was held in the York County Buildings at Toronto, on February 27th and 28th and March 1st. About three hundred delegates, representing thirty-five counties, were present.

The morning of the first day was spent in registration and the formation of committees.

In the afternoon, the delegates were welcomed by Mayor Church and addresses were delivered by President C. R. Wheelock and Geo. S. Henry, secretary of the association.

In the course of his address, Mr. Wheelock declared that it is upon good roads that victory depends in the present war and suggested a co-operative system between the railroads and "highway freight trains" as a means of relief in the congestion of traffic which is retarding the movement of men, munitions and materials on this continent.

On the second day Hon. Findlay Macdiarmid, Minister of Public Works and Highways, in reviewing the spread of the movement in the province, stated that all the counties except Peterborough and Northumberland are

now co-operating with the association. W. A. McLean, Deputy Minister of Highways, advised caution in borrowing so as not to embarrass the government.

Wimund Huber, Ontario Department of Public Highways; Daniel Quinlan, treasurer of Simcoe County; and E. M. Young, clerk of Prince Edward County, dealt with the matter of finance from the point of view of the association. Mr. Young suggested that the same system of bookkeeping should be adopted in all counties and also that the government might establish a department for purchasing the machinery for road building.

D. M. McIntyre, K.C., chairman of the Ontario Railway and Municipal Board, delivered an interesting address on "Highways of Empire," and F. A. Senecal, clerk of the counties of Prescott and Russell, and J. F. Vance, clerk of the county of Wentworth, spoke on the subject of "Road Organization."

Before the close of the meeting, a resolution was adopted asking the government to facilitate the haulage of stone on the highways.

On Friday morning, general discussion and the election of officers took place.

The following officers were elected for the ensuing year: Hon. presidents, J. A. Saunderson and S. L. Squires; president, C. R. Wheelock; vice-presidents, J. J. Parsons, W. H. Pugsley; secretary-treasurer, George S. Henry, M.P.P.; directors, K. W. McKay, Major Kennedy, F. A. Senecal, L. E. Allen, G. Mahoney, M. J. Brown.

PRESIDENT OF CANADIAN SOCIETY OF CIVIL ENGINEERS ADDRESSES TORONTO BRANCH

On Tuesday last, March 5th, H. H. Vaughan, president of the Canadian Society of Civil Engineers, addressed the members of the Toronto branch on "The Possible Activities of the Society Under the New By-laws."

In the course of his address, the speaker explained the reasons for the changes being made and suggested ways and means by which the branches might co-operate in an effort to make the society a still greater factor in the life of the engineer, and enable him in a fuller sense of the term to occupy the place in the community to which his training and capacity entitle him.

Fraser S. Keith, secretary of the society, also addressed the meeting, which was held in the Chemistry and Mining Building, University of Toronto. Prof. Peter S. Gillespie, chairman of the Toronto branch, presided.

CANADIAN ASSOCIATION OF ENGINEERS

Last Thursday, February 28th, a meeting of civil engineers was held at 228 Beverley Street, Toronto, to discuss informally the advisability of organizing a Canadian Association of Engineers along the same lines as the American Association of Engineers.

There seemed to be a decidedly strong feeling among the dozen men present that some concerted effort should be made to improve the financial status of the engineer, especially the younger men in the profession.

The question arose as to whether the organization should take the form of a local chapter affiliated with the American association or operate as a Canadian association conducted along lines similar to those of the American association. This matter was left open.

Another meeting is to be held on March 21st, when the proposed organization will be further discussed and some form of constitution decided upon.

WINDSOR GARBAGE INCINERATOR

THE reconstruction and enlargement of the garbage incinerator at Windsor, Ont., has just been completed by the Canadian Incinerator Co., Limited, of Toronto. The plant is of similar design to those which that company had previously installed at Kitchener, Ont., and Transcona, Man., although some new features have been added which improve the efficiency and reduce the cost of operation still further.

In each cell there are 35 sq. ft. of grate bar area, and it is there that the actual incineration of the garbage is accomplished. Behind this area there is a drying hearth upon which the wet garbage is deposited in such position that the hot gases pass under, through and over it, ensuring rapid drying. A special flue carries all gases into the combustion chamber. In passing on toward the chimneys, they come in direct contact with a separate chamber where the whole carcass of an animal can be cremated within a few minutes.

From this animal chamber the gases pass on through a pre-heater, where hot air is generated. This hot air is conducted under the floor into the air chamber, from which the fireman liberates it into the ash pit at will by means of a special device, using it to create a forced draft. A special design of grate bar makes the forced draft come evenly upwards directly under the fire, thus greatly accelerating the burning.

The feed holes are all water-sealed, eliminating the possibility of any gases escaping onto the dumping floor even if the furnace be filled to its capacity.

The clinkering doors are of the guillotine type, practically the full width of the furnace, giving the fireman full access to the whole furnace for cleaning purposes. These doors are counterbalanced by weights placed inside the channel buckstays and are easily handled.

One oil burner is installed in each cell of the furnace and two in the animal chamber. These, however, are used only for a few minutes when starting the fires or when exceptionally bad garbage is encountered. In two of the plants mentioned above, the oil burners have not been used for more than a year past, as the plants are capable of destroying all ordinary garbage without the help of any fuel.

The appearance of the Windsor furnaces is very neat. Glazed bricks are used in the front and obvious effort made to obtain a presentable plant. Sufficient steel supports or buckstays have been used to obviate heavy repair costs.

A Hydro-electric system has been installed in the Portland cement works at Durham, Ont.

Leclaire and Fils, of Sorel, P.Q., have received a contract for the construction of six steel ships, costing $1,500,000.

Members of the designing and operating staff of the engineering department of the Dominion Iron & Steel Co., Ltd., Sydney, N.S., recently formed an engineering society.

A discovery of bauxite has been reported from Kamloops, B.C., and another from near Vancouver. A discovery of 2 per cent. nickel pyrrhotite is reported from Jervis Inlet. Bauxite in quantity would assure an important new industry.

ERECTION OF KETTLE RAPIDS BRIDGE

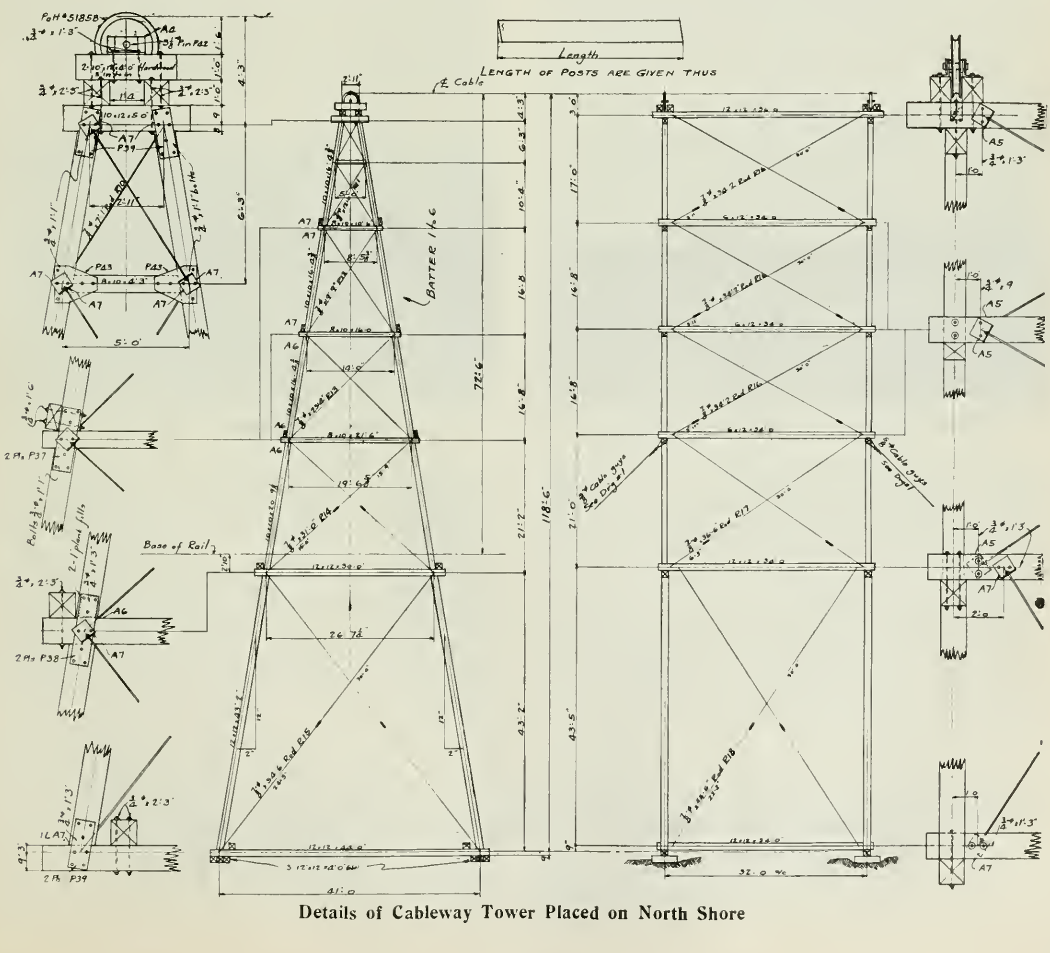
By Sterling Johnston

Assistant Manager of Construction, Canadian Bridge Co.

STAGING of no kind could be used for placing the main channel span of the Kettle Rapids Bridge. This fact, and the remoteness of the site, made the erection of this bridge unusual in character. The site was at the end of a long construction line leading from The Pas, precluding the possibility of bringing in from the north the material required for the north end. The problem of getting the north half of the structure across and in place economically formed one of the chief considerations.

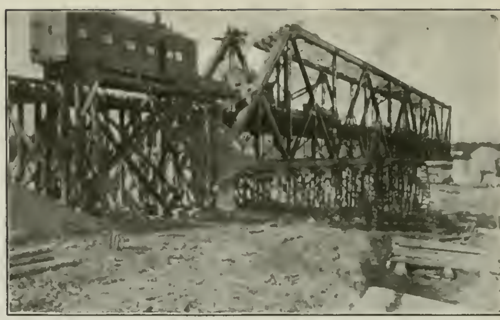
The Kettle Rapids bridge is on the line of the Hudson Bay River and crosses the Nelson River at a point 332 miles north of The Pas, Man. At the point where the bridge is located is a deep, narrow gorge through which flows a swift rapids directly in the way of the site chosen for this crossing. The banks on either side of the river at this point are solid rock for a considerable distance back from the shores and the existence of this rock formation was a determining factor in selecting the continuous-girder type of truss adopted. The design consists of a single track through-truss structure, 1,000 feet long, which is carried continuously over four supports. The channel span is 400 feet long, centre to centre of pier members, while the two flanking arms are each 300 feet long. The trusses are of the Warren type, having 50-foot main panels sub-divided to form two 25-foot stringer panels. These are 50 feet deep, centre to centre of chords and are placed 24 feet apart. All the truss joints are riveted throughout. The floor system is of the ordinary open floor type, having wooden ties carried on two lines of built-up stringers, which in turn frame into the webs of the floor beams. The simplicity of this design greatly facilitated the fabrication and erection of the bridge. The following erection program was adopted:—

The south arm between piers Nos. 1 and 2 was erected on wooden staging with an ordinary derrick car, the only unusual feature being that L-O was erected 10 inches lower than its normal elevation in order to allow for deflection in cantilevering. The truss as a whole was also erected on the permanent pier member rollers about 5 inches closer to the shore than its normal position. The main joints were then completely riveted and the derrick



Details of Cableway Tower Placed on North Shore

Portal, Looking North



South Flanking Arm in Place; Cantilever Erection

car erected the balance of the south half of the crossing as a cantilever from L-12 to L-20. The riveting followed the erection very closely so as to take care of the erection stresses.

A cableway tower was then erected on the north shore, materials for same being hauled by team over the ice at a point some distance from the crossing. A short cableway bent was also erected on the completed truss at U-18 and a double cableway made of two 2¼-in. diameter cables was erected on these towers and securely anchored at both ends. These two cableways were operated by two

as to bring the trucks level with the top chord of the span, and the balance of the steel for the north anchor arm completed, going forward from U-2 to U-12. After riveting this anchor arm the cantilever portion of the truss between panels 12 and 20 was easily completed with the traveller running out on the top chord.

The whole of the south half of the bridge was then jacked forward on the permanent pier member rollers and a coupling made at L-20. After this joint was riveted jacks were applied at the two extreme ends of the bridge, points L-O north and south ends. These ends were raised

Overhead Cable. Tower is Shown in Distance

South Half of Bridge Under Way

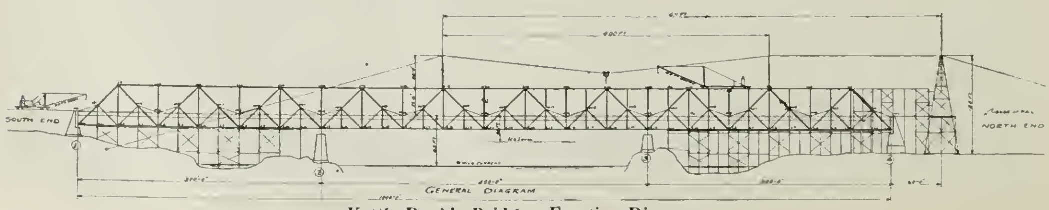
double-drum hoisting engines, and carried a flexible equalizer designed for lifting fifteen tons. The materials for the north end were then brought out on cars to the extreme end of the cantilever truss on the south side, and materials transferred by means of this cableway to the north side.

The staging for the north anchor arm was first erected and on this a light double-boom traveller assembled.

The steel work was then transferred and placed with this traveller, starting at L-12 and erecting the lower half of the anchor truss, backing up with the traveller until L-O was reached. The traveller was then jacked up so

until the joint at U-20 was closed, after which the four corners were raised simultaneously until a load of 118½ tons was registered on each of the four jacks, which fixed the distribution of the dead load stresses throughout the entire structure.

The entire work was under the general supervision of A. W. Bowden, chief engineer, Department of Railways and Canals, Ottawa. The bridge was designed by W. Chase Thompson, consulting engineer, New Birks Building, Montreal. The superstructure was fabricated and erected by the Canadian Bridge Co., Limited, Walkerville, Ont.



Kettle Rapids Bridge—Erection Diagram

United States Engineering Council

Official Outline of the Aims, Field and Progress of the Joint Organization of American Civil, Mechanical, Mining and Electrical Engineering Societies

By ALFRED DOUGLAS FLINN, M.Am.Soc.C.E.
Secretary, Engineering Council

ENGINEERING COUNCIL held its first meeting June 27th, 1917. In the months which have elapsed, useful services have been rendered to the government, to engineering societies and to individuals, and progress has been made in perfecting Council's organization. Offices have been secured in the Engineering Societies Building, New York City, the focus of engineering activities in America. A permanent secretary has been engaged and several important committees have been created.

Engineering Council is an organization of national technical societies of America created to provide for consideration of matters of common concern to engineers, as well as those of public welfare in which the profession is interested, in order that united action may be made possible. Engineering Council is now composed of the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers, having a membership of 33,000 and known as the Founder Societies.

A patents committee, to investigate reforms in the United States patent system and in the use of experts in litigation wherein the validity of patents or other technical matters are involved, was also created. The committee was instructed to co-operate with any committee of the National Research Council, and with committees of other technical societies organized for a kindred purpose.

Limitation of financial resources has been and still is one of the greatest handicaps. At the beginning of this year, an appropriation of $16,000 by United Engineering Society, contributed equally by the four Founder Societies, became available for the period ending October 31st, 1918. Although this sum provides for the usual expenses of the secretary's office, for inaugurating several permanent lines of service and for a few special items in connection with the war, it is far from adequate.

Engineering Council is still forced to go slowly on work already undertaken and to decline or defer other meritorious projects. That Engineering Council has accomplished as much as it has is due chiefly to the fact that individuals, societies and government bureaus have informally contributed services and means. Additional income must be had if Engineering Council is to bring to pass within a reasonable time many of the things rightfully expected of it for the benefit of professional engineers, the country, the government and the public.

Restriction of membership in Engineering Council to the four societies just mentioned is not intended. Quite to the contrary, it is planned and earnestly desired that other national engineering and national technical societies shall become affiliated, thus making Engineering Council truly representative of the hundred thousand engineers in all branches of the profession throughout the United States. Conditions and methods for the admission of additional societies have been developed. Henceforth, a chief aim of Engineering Council will be to increase the number of member societies and thus gain not only an enlargement of its capacity for usefulness along its chosen lines, but also greater technical and financial support.

So extensive is the field of possible activity for Engineering Council that even yet it is unwise to set its bounds. Nevertheless, some of the proposed activities may now be outlined. Foremost among these is the fostering of a sense of solidarity throughout all divisions of the profession in all parts of the country—the increasing of a sense of common interest and of the strength that results from unification. To this end, subordination to the general welfare of the preferences and pride of organizations and of persons may be necessary; but it is confidently expected that even through difficult places the right paths will be found. Patience and good sense will win full and effective co-operation.

Publicity of a high order, but of a practical sort, must be devised that both engineers and the public may be informed not only of engineering achievements in physical work, but also of the services which peculiarly pertain to engineers, in mental realms, those which they are performing and those which they should perform. Engineers and engineering must be made more comprehensible to the people up and down the land, and kept instructively and interestingly in the public prints. A most important service is the standardization of definitions, methods, requirements and tests for all varieties of engineering materials and work. Others are the improvement of the methods and requirements of engineering colleges, the standardizing of the meanings and values of the degrees given to graduates, and the broadening of the engineer through knowledge of humanitarian subjects, in which other professional men take interest.

Mutual helpfulness in getting the right engineer for the empty niche of usefulness and in finding an empty niche for the unemployed engineer, or for the one seeking advancement has for years been a need of engineering societies, widely voiced, especially by the younger men. Many endeavors have been and are being made to meet this need, with more or less success; but most of them have been limited. Engineering Council has already given this matter much thought and has put it in the hands of the American Engineering Service, one of its committees. To meet these demands, this committee has been assembling in its offices in the Engineering Societies Building, New York, comprehensive lists and much detailed information concerning engineers in all branches of the profession.

During the past few months, there have been supplied to government departments and bureaus several thousand names of engineers, from which men were selected to fill a great variety of positions in uniformed and civilian service for the army, the navy and other branches of the government's activities in connection with the war, as well as for manufacturers and contractors engaged upon government war work. Hitherto, these war demands have absorbed most of the energies of this committee and its staff, but incidentally there have been accumulated great masses of live material which can in the near future be

re-cast into a suitable mold of classification and indexed for permanent use.

On methods of classifying and indexing, the committee has already done not a little work. It is the intention to discover what has been done by others and so to combine and strengthen all useful systems as to secure the greatest benefits for engineers, for employers and for local, state and national governments. It is the aim ultimately to create a complete, skilfully classified catalog of all American professional engineers. This body of information will have many obvious uses, as well as others that will be discovered.

It has become evident that although numerous engineering societies are occupying limited fields efficiently, and although some of these fields are extensive, there are large sectors of the domain of the engineer which are either but weakly held, or else are usurped by others. This condition has arisen partly from specializing tendencies among societies as well as among individuals. Until the present time, there has been no central agency capable of entering these sectors and competent to speak for the profession at large; no duly constituted representative to learn of the share in local civic and governmental enterprises which should be the engineer's, to claim it for him, and to see that he gets it; no organization to harmonize the action of the profession on similar questions in different localities; no interpreter to the public of the engineer, his work, his ideals and his methods; no body to develop meritorious projects for the general good of the profession or for the benefit of the public; no one constantly on guard to detect and oppose objectionable schemes and tendencies. To fill these gaps is the great aim of Engineering Council—not by demolishing any useful existing agencies, but by building these into a well-proportioned and thoroughly furnished structure. Time will, of course, be required for erecting and perfecting such an organization with its necessary local branches covering all the United States.

Engineers are organizers and should be directing their abilities as such to the greater service of the nation. No better demonstration of the need of such a centralizing body as Engineering Council could be had than the multiplicity of existing engineering organizations, and especially the manifestation during recent months of this tendency to segregation exhibited in efforts to serve the government in connection with the war. Order is slowly being brought into this confusion, but if Engineering Council could have been well established before the beginning of the war, it would have become at once the connecting link between the government and engineers, securing results quickly, directly, economically and in an orderly manner. While contributing its best endeavors to the winning of an early and complete victory, Engineering Council must be shaping its organization so as to be prepared to aid engineers in taking the leading part which must be theirs in the years following the conclusion of peace.

Unselfish service and mutual helpfulness must be the test requirements for all the undertakings of Engineering Council. Offensive political or business activities must be avoided and the selfish aims of groups or individuals must not be fostered. If the work roughly outlined be carried forward in this spirit, no fear need be entertained for the profession's ethics, its honor, or the standing of the engineer in the community.

The Carnegie Corporation, New York, has given McGill University a million dollars in recognition of war services.

SEWER PIPE JOINTS*

LESLIE WOODFALL, C.E., Boston, Mass.: Joints in sewer pipe, until recent years, has been made mostly with cement. I have been informed that in England well-puddled clay was used to a considerable extent; also the so-called Stanford joint. This latter joint, I believe, was patented and was never extensively used in this country. It was made by filling the inside of the bell with a hot mixture similar to asphalt. The outside of the spigot was then chipped so as to allow it to be covered for a short distance with this same mixture. Molds, made so as to give a beveled surface, were used for pouring the material, and the pipes were forced together, thus making a tight joint. I understand some pipe was manufactured with the spigot end made so as to avoid the chipping.

Cement Mortar Joints

Different methods of making cement joints are: First, by the use of cement mortar alone; second, by caulking a gasket, either dry or soaked in liquid cement, into the bell and then filling the bell with cement; third, by placing the cement in the joint and then caulking the gasket in, thus forcing the cement into the bell; and fourth, by the use of cement alone, forcing it thoroughly into the joint with a caulking iron and covering the joint with cheese-cloth for the purpose of holding the cement in place. In this latter joint small wooden blocks are imbedded in the cement of the bell for the purpose of centering the pipe.

An additional precaution to make the joints tight was used at Malden. This consisted in the use of a small wooden box having the sides cut to the radius of the outside of the pipe, which was placed at the joint and filled with cement mortar up to the middle of the sewer pipe. I used this method a number of years ago, but it did not prove entirely satisfactory.

Poured Joints

Under this head may be included all of the methods of pouring the joints with hot mixtures. These mixtures are of two distinct classes, *viz.*, that known variously as G-K, Jointite, etc., and that composed of sulphur and sand.

For making any of these joints, deep and wide socket pipe should be used. A gasket is first caulked into the bell in a thorough manner, to prevent the material from running into the pipe. A gasket is then clamped around the pipe and the hot material poured in the same manner as in making water pipe joints.

Water must be kept out of the bell while the sulphur and sand is being poured. It is claimed that with G-K, or Jointite, this is not necessary, but from such information as I have obtained I judge it is difficult to make a good joint under water. The sulphur and sand joint becomes hard at once, but it is so rigid that the pipe will break if any settlement takes place. The G-K or Jointite compounds do not harden so quickly and have enough elasticity to take care of any slight settlement of the pipe.

In my experience covering thirty years, I have seen three small cases of broken sewer pipe. In one case the joint was made with cement while in the other cases sulphur and sand was used.

Careful levels indicated that the breaks were not caused by a settlement of the pipe.

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*Abstracted from discussion in Journal of Boston Society of Civil Engineers.

Among the reasons for building sewers as nearly watertight as possible are the following:—

First, to avoid increasing the size of the sewers to provide for an extreme leakage; second, to prevent the pumping of an unnecessary amount of ground water; third, to prevent the treatment of an increased amount of sewage caused by the leakage of ground water into the sewers; and fourth, to prevent the entrance of tree roots in the sewers through imperfectly made joints.

Taking everything into consideration, my conclusions are that a nearer water-tight joint can be secured by pouring.

EDWIN H. ROGERS, City Engineer, Newton, Mass.: The city of Newton, Mass., has a separate sewerage system, and for the past eleven and one-half years a sulphur and sand compound has been used exclusively as a jointing material for its vitrified pipe, sanitary sewers, and house connections, and for a limited amount of surface drains.

The method of making the joints in the pipes is similar to the pouring of lead joints in water mains.

The quantities of material per joint required for 8-in. pipe are about as follows: Sulphur, 1½ lbs.; sand, 1½ lbs.; jute, ½ lb.; pitch, 0.4 lb. For 5-in. pipe the quantity of sulphur is about nine-tenths pound, and other materials in proportion. On the basis of present-day prices, the cost of materials for an 8-in. joint would be from 11 cents to 12 cents, but until recently the cost has been considerably less.

HENRY A. VARNEY, Town Engineer, Brookline, Mass.: Brookline has tried many different materials for sewer pipe joints, but as yet has found nothing that is entirely satisfactory.

For many years Roslindale cement mortar was used, and no great care taken in forming the joint, which resulted in much trouble from tree roots, and a large amount of leakage in wet ground.

Later on, Portland cement was substituted for the natural cement, and the pipe centered with a jute gasket. But with every precaution we were able to enforce, such as the use of rubber gloves in applying the mortar and deferring the heavy backfilling until the cement had thoroughly set, the results were not at all satisfactory. In one case where there was a large amount of ground water, we constructed wooden boxes to fit the lower half of the pipe and long enough to extend each side of the bell. These were set to the proper grade, then filled with rich mortar, so there could be no question but that each joint was thoroughly bedded and protected. With all these precautions, there was considerable leakage. In another instance we encased the entire pipe in 6 ins. of concrete, but with no better results.

We then tried the sulphur and sand joint similar to that used in Newton. By this method we greatly reduced the amount of leakage, but we were apprehensive that such a rigid joint as this material makes from the moment it is poured would result in cracks in the bells or the pipe itself, for it is difficult to bed several lengths of pipe so as to prevent all possibility of movement when the backfilling and puddling is completed.

Data Relating to Sewer Pipe Joints

City or Town.	Material Used.	How Long Used.	Why Is This Material Used.	Work Done by City or Contract	Other Material Used.	Have You Had Trouble From Tree Roots?	Does Present Type Prevent Roots?	Does it Make Water-Tight Joints?	What Material Used in House Connections	Remarks
Boston	Cement mortar	30 yrs.	No better for all purposes	Both	None	Yes	No	No, except with extreme care	Cement mortar	Experiment under way with special material.
Brockton	Portland cement	25 yrs.	Think it the best	City	G-K compound	Yes	No	Yes	Portland cement	Iron pipe with lead joints used where roots give trouble.
Brookline	Asphaltic compound	10 yrs.	Gives best results	Contract	Cement, sulphur and sand G-K compound	Yes	Yes	When carefully used	No regulations	House connections laid by private contractors.
Cambridge	Cement mortar	28 yrs.	Considered practical	City	Bituminous filler	Some	Yes, if carefully made	Yes	Cement mortar	
Concord, N. H.	Cement mortar	25 yrs.	Makes effective joint	City	Roman cement	Yes	Yes	Yes, when well made	Cement mortar	
Haverhill	Cement mortar	Many yrs.	To prevent entrance ground water and tree roots	City	None	Yes	Yes, if done properly	Yes	Cement mortar	
Lawrence	Cement mortar	Always		City	None	Yes	No	No		Combined system of drainage.
Lynn	Cement mortar	40 yrs.	Most convenient	City	None	Yes	No	Nearly	Cement mortar	Iron pipe with lead joint used where tree roots give trouble.
Malden	Cement mortar	26 yrs.	Considered best	Both	G-K compound	Yes	Yes, if made properly	Yes, if made properly	Cement mortar	
Melrose	Cement and G-K compound	G-K past 2 yrs.	On account of wet trenches and tree roots	City		Yes	Yes	Yes	Any	Trouble with tree roots in house connections and some main sewers.
New Bedford	Cement mortar	Many yrs.	For convenience and economy	City	G-K compound	No		No	Cement mortar	
Newton	Sulphur and sand	11 yrs.	Permanent water-tight and resistant to roots	Both	Cement mortar and bituminous compound	No	Yes	Yes	Sulphur and sand	
Pawtucket	Cement mortar	20 yrs.	Most satisfactory	Both	None	Very little	Not entirely	Not entirely	Cement mortar	Quality of work depends upon inspectors.
Worcester	Cement mortar cloth wrapped	20 yrs.	Because it has given good results	City	None	No	Yes	Fairly	Cement mortar	
Metcalf & Eddy	G-K compound	5 yrs.	A poured joint considered best	Contract	Sulphur and sand	No	Yes	Fairly so	G-K compound	

We next experimented with various bituminous compounds, and in 1909 used a mixture of asphalt and sand in laying a 30-in. sewer. This gave so much better results than anything we had previously tried that we continued its use, and up to the present time have found nothing that is more satisfactory, considering the ease of manipulation, cost, etc. The method of making a joint with this material is similar to that used for lead joints, except that the material does not have to be caulked. It also required very little heat to bring the compound to the proper consistency, a small wood fire being all that is necessary. We take the precaution to fill the angle between the bell and the barrel of the adjacent pipe with cement mortar, but do not think this is absolutely necessary, especially in the smaller sizes of pipe.

We have recently inspected some of the first work done with this material and have found the joints in perfect condition, and could see no change in the consistency of the compound itself.

In the accompanying table are tabulated the results of an inquiry as to methods used in other communities.

COUNTY ROAD SUPERINTENDENTS CONFER

The fourth annual conference on road construction for county road superintendents and engineers was held under the auspices of the Ontario Department of Public Highways, February 25th to 28th.

The papers which were read provoked an unusual amount of discussion. The discussion was led this year by the superintendents and county engineers themselves instead of, as in former years, by engineers of the department.

The attendance was larger than had been anticipated and the enthusiasm of all who were present would indicate that the conference fills a want in the experience of the men who are responsible for the construction and maintenance of highways in Ontario.

The following county road superintendents and engineers were in attendance: Thos. R. Allison, Wentworth; Wm. Watters, Lanark; John M. Young, Wellington; Peter Robertson, Lincoln; Wm. Forbes, Oxford; H. G. Bleecker, Hastings; C. R. Wheelock, Peel; Chas. Talbot, C.E., Middlesex; T. V. Anderson, Lennox and Addington; H. D. Cleminson, Prince Edward; J. G. Wilson, Halton; John Roger, C.E., Perth; R. H. Fair, Frontenac; M. D. Hallman, Waterloo; Samuel McClure, Carleton; E. R. Blackwell, Leeds and Grenville; E. A. James, C.E., York; D. W. McBurney, Haldimand; W. W. Brookfield, Welland; F. A. Senecal, Prescott and Russell; J. G. Cameron, Dundas, Stormont and Glengarry; A. R. McVicar, Brant; D. J. Izzard, Bruce; G. R. Marston, Norfolk; L. A. Pardo; Kent; Frank Pineo, Elgin; Robert McQuigge, Renfrew.

HONOR ROLL FOR TORONTO BRANCH

The Toronto Branch of the Canadian Society of Civil Engineers is preparing an Honor Roll. Members are requested to send the names of men who are now serving in the Imperial or Canadian armies to George Hogarth, secretary, Parliament Buildings, Toronto, or J. R. W. Ambrose, Toronto Terminals Railway Co., 36 King Street East, Toronto.

LIGNITE COAL IN MODERN STEAM PLANTS*

By T. L. Roberts, A.M.Can.Soc.C.E.
Consulting Engineer, Winnipeg.

THERE has been a great deal written about lignite coal and a great many tests of this coal have been made, and a conclusion has been drawn that this coal cannot be utilized economically unless it has been put through a certain process of manufacture, such as briquetting, gas or powered fuel. More recent experiments have found that the coal can be handled in its natural state, without special preparation, and that economical results can be obtained as well from this coal as from other coals which have a greater percentage of heat value, and less ash.

In making an analysis of any coal, there are two ways in which it may be done, each of which furnishes information of considerable interest and value to the engineer. Of these analyses, one, called an ultimate analysis, determines the percentage of the various chemical elements of which the coal is composed, but does not necessarily show in what manner these elements are combined. It shows that, if a sample of the coal is separated into its elements, these will be certain proportions of oxygen, hydrogen, carbon, etc. These proportions are generally expressed in percentages of the weight of the original sample, the weight of which is considered as a unit, or 100 per cent. From the ultimate analysis, the heating value of coal may be estimated.

Although the ultimate analysis of a fuel presents difficulties that render it impracticable for any but a skilled chemist, there is a method by means of which a careful engineer can acquire an amount of skill that will enable him to determine the percentage of water, volatile matter, fixed carbon, and ash, with a fair degree of accuracy. This method is called a proximate analysis, and is described in any engineers' handbook.

Another method commonly used among old firemen is to take a few lumps of coal at random from the pile, pound them up with a hammer till very fine, then fill a clay pipe, place the pipe in a position to be able to watch the effect, care to be taken that the bowl is set firmly among pieces of red-hot coal in the fire-box or on the floor of the boiler-room on a shovel. When the powdered coal in the pipe bowl is burned to ashes, from this ash is determined the quality of the coal. The impression so gained is very hard to change. When the chemist takes samples at random he later places all of them together, subdividing them many times, each time reducing a section and subdividing it, till at last his final sample is a good average of the whole.

Analysis of a Few Coals Used in Winnipeg

	Moisture.	Volatile.	Fixed carbon.	Ash.	B.t.u.
Anthracite	3.46	3.86	83.77	6.6	14,000
Semi-anthracite ..	.65	9.40	83.69	5.34	15,500
Semi-bituminous .	1.0	21.0	74.39	3.03	15,700
Bituminous	1.03	36.50	59.05	2.61	15,000
Sub-bituminous ..	2.8	40.7	50.85	5.65	12,500
Manitoba lignite..	23.49	35.01	31.50	9.99	8,128

A good steam coal is the semi-bituminous of these pochontas and the standard of this part of Canada. The price of this coal is naturally the basis on which all coals

*Abstracted from paper read before the Manitoba Branch of the Canadian Society of Civil Engineers.

are sold. Seventy per cent. of the heat units is practically all that can be used to make steam. It will be found that a pound of coal requires practically the same amount of air whether it be anthracite or bituminous. Roughly speaking, it requires 160 cubic feet of free air, but with forced draft it has been found that a fan must be supplied which will give 260 cubic feet for each pound of coal to be burned, on account of leaks, etc. By the use of a hand gas analysis machine the air required will be quickly determined and by adjusting the dampers to suit these readings draft gauges will show how much air is required according to the depth of fire needed for the work the boiler has to do or is made to do. Chimney draft is generally read by gauges which are inserted in the breeching. It will be noticed that when the dampers are changed the chimney draft will vary. Kent's table of chimney capacities is ample and safe, and the full capacity can, as a rule, be found without heating the stack. In the writer's opinion, chimneys should be used only to take the burned gases away from the power house, and draft to burn coal should be supplied by a fan under the grates. Fires require fresh super-heated air to bring the supply up to the fire-box temperature, fresh, not burned. As an experiment, hot air from the combustion chamber was used with the result that the fan drawing the air out of the combustion chamber nearly put the fire out, and the steam pressure dropped. The fan connection was changed as before and the fire burned up again quite brightly. Dampers play a very important part in boiler settings and, as it has been said, the firemen's throttle is the damper. They should be arranged so that perfect control can be maintained at all times and they should not be made too large in section. If the breeching is 1/5 larger than the flue area it will answer and when this area calls for dampers of any size that may cause warping from the hot gases, they should be made in several sections and rigging arranged, connecting them altogether to a common control point with proper adjustable notches for fine adjustment.

When firemen have the draft gauges of each boiler set and they are instructed to keep the draft at the economical point, which point has been previously determined by the CO_2 recorder, these dampers will require to be changed frequently. It appears that forced draft is the only means by which the coal can be burned with economy on account of boiler load changes and the demand for better draft regulation. The fireman depends on the draft in the chimney, but this varies according to the weather; with forced draft his breeching dampers may be partly closed when his fire is getting heavier and he can give the fire more air, get more out of the boilers and keep up his CO_2 requirements.

Fire-box design for stationary boilers has changed a great deal in the last few years. The dimensions were formerly determined by the width of the boiler, by the length of the first plate in return tubular boilers and by the grate surface for others. One square foot grate surface to 40 square feet of heating surface was a common rule, and when the grate length exceeded 6 feet the sides were never made wider than the boiler. Some years ago the engineer who designed the Bank Head Mines for the Canadian Pacific Railway set up eight 150-h.p. return tubular boilers with a grate surface of 1 to 20 and explained that this was on account of the low heating value of the buckwheat coal they intended to burn. These boilers were set very close to the grates. Now settings of 1 to 27.5 are used for low-grade coal. The bridge walls were always made close to the boiler and also made to follow the curve of the boiler and the seam of the return boiler was always placed near the bridge wall to keep the extra thickness of plate out of the fire. Now that CO_2 records have been watched, all these high-speed gases at points like this have shown that the boiler only requires to be suspended in a bath of heat and the flow of gases reduced to slowest speed while they have any heat left, so that the sides of the fire-box are made straight and the boiler is lifted out of the fire and the bridge wall is only a place on which to rest the end of the grates, and ample room is left so that the gases can pass by with less velocity. Slow-burning coal and lots of coal in the fire-box gives the desired results and the fire-box volume is the thing that counts. A grate surface of 1 to 20 with 1 square foot of grate to 8 cubic feet of fire-box volume, which is made up mostly by raising the boiler from the grates, gives such a setting that with forced draft an almost unlimited horse-power can be taken out of the same boiler.

A paper written many years ago by Lawford Fry on tests made by the Baldwin Locomotive Co., stated that fire-box volume would prove to be the governing factor, not grate surface. All this has come into modern practice. Take the case of a locomotive. These boilers, when used for stationary boilers, develop under natural draft 150 h.p., and when pulling up hills or on fast trains develop 1,200 to 1,400 h.p.

The development of modern steam boiler plants to keep pace with the prime movers has caused engineers to push the development of the stoker to a surprising extent. Although the prime movers have been doubled and trebled, the same boilers now handle the load by forced draft and settings that keep the boiler far away from the fierce force of the fire on the grates. Boilers on bank can now, with lignite, be put on the line in a few minutes. Tests made by one of our leading power plant equipment companies who make three kinds of stokers, have developed their forced draft stoker till they can now give a guarantee that they will place the boiler plant in shape to give 300 per cent. to 400 per cent. rating with lignite coal at 70 per cent. efficiency, 65 per cent. on lower ratings. This means, with lignite coal, 6 pounds per horse-power-hour, while to-day most plants in the West are only getting one horse-power with 5 pounds of the best coal money can buy, in place of 3 to 2½ with stokers.

These large modern plants, when burning coal at the rates referred to, find that the ash in lignite coal is far less than is the common impression and, in fact, there is less ash than in eastern coals. One of the points in favor of burning lignite coal with forced draft is that the ash is so light a great deal goes up with the stack draft, and soot-blowers are used to remove the deposit to the stack and the combustion chamber, so that very little remains in the ash pit.

Clinkers, though, are quite a problem. Double-dump grates are among the latest and most successful methods of disposing of the clinkers. When coal is properly burned and all the value taken out of it, the refuse should be clinker alone.

ENGINEERS TO DISCUSS FUEL SITUATION

A general meeting of the Canadian Society of Civil Engineers will be held in Toronto, March 26th and 27th. Means will be discussed whereby engineers may assist in solving the national fuel and power problems that confront the Dominion.

SUPERVISION OF PUBLIC WATER SUPPLIES BY THE HEALTH OFFICER*

By Jack J. Hinman, Jr., M.Sc.
Water Bacteriologist and Chemist, Laboratories for the State Board of Health, State University of Iowa.

FROM the health officer's standpoint the two essentials for a public water supply are, first, that it shall be safe water for drinking and all domestic purposes as it comes from the mains; second, that there shall be an adequate quantity for the ordinary uses of the community with a sufficient reserve to take care of emergencies. Another matter of importance to the health officer is the attractive quality of the water, an agreeable taste, a suitably low temperature, freedom from odor, color and suspended matters.

We should first consider the quantity factor and then take up the question of the quality of the water, because the quality of the water is more nearly under our control. In this country the daily per capita consumption of water from public supplies varies between 40 and 300 gallons. In Iowa City during the past few years the consumption has run from 97 to 167.5 gallons per person per day. The local installation of meters has reduced the waste of water, but the daily pumpage approximates 100 gallons per person. In installing a plant, the probable increase in population for a determined period is calculated by ordinary statistical methods and this is taken as a basis on which to figure the probable amount of water required. Fire protection requires that a sufficient reserve of water be maintained. On one occasion, on account of a fire, it was necessary for the local plant to pump nearly a million gallons of water more than the usual daily pumpage. This represented an approximate doubling of the quantity of water treated. If the quantity of safe water available is too small, it becomes necessary to turn to a polluted stream or pond for water. In consequence this foul water may lie in the mains and dead ends for a week or more before it is replaced by a safe supply. Naturally, the use of the polluted water is dangerous, and when an emergency has required such a measure, the public should be warned by posters and newspaper notices. Such measures. however, are not usually efficient. Competent engineering advice is needed in deciding if a water supply will be sufficient. If the town is very small, wells may probably be assumed to yield the required amount. If their water contains too much iron or is polluted, simple measures may be resorted to to remove the difficulty. As the town increases in size, the number of wells and the necessary plant rapidly increase. Deeper wells may yield more and safer water, but water which is often so heavily laden with solid matters as to be almost useless for ordinary industrial purposes. Infiltration galleries may be laid in stream valleys. Their waters take on most of the characteristics of shallow well supplies. Creeks or larger streams may be held back by dams and considerable quantities stored for use. If the water sheds of the streams are prepared and then patrolled to keep away polluting agencies, the impounded water may be of quite good quality. If no provision is made for protection, the water approaches ordinary stream or river water. Impounded supplies are troubled by algae, which often gives rise to odors and tastes. The water of almost any stream may be made safe for drinking purposes, but I do not know of any stream in Iowa which furnishes water which is safe for use in its raw condition.

*Abstracted from paper read before the School for Health Officers, Iowa City, Ia.

Common Methods of Purification

I want to make a brief mention of the limitations and advantages of the common methods. Storage of impounded water effects a certain amount of purification. In London, for example, storage for a period often exceeding a month is depended upon as one of the chief factors in the purification of the heavily polluted Thames water. This purification consists chiefly in the settling of the suspended matters, a bleaching of the color and a reduction of the bacteria due to sedimentation, food conditions, sunlight, etc. London then filters the stored water. Stored water is often troubled by growths of algae and lower animal forms when stored in the open air. Odors and tastes sufficient in amount to cause complaint by the consumers sometimes results. The usual preventive measures are storage in the absence of light in covered reservoirs and the treatment of the surface water, particularly at the shore line, with copper sulphate. It is applied as a spray or by rowing about the reservoir a boat to the stern of which a bag of copper sulphate crystals has been tied. The copper rapidly precipitates from the water and it is usually copper-free in twenty-four hours or less. Coagulation of a water is usually brought about by the addition of filter alum (more accurately known as sulphate of alumina, since it is not a double salt) or lime and sulphate of iron. The advantage of the latter process lies in the cheapness of the iron sulphate, which is a byproduct of the steel industry. In order to remove all of the iron, however, it is necessary to add somewhat more lime than is needed to use up all of the free carbon dioxide which exists in the water. Our local raw water contains about forty parts per million of free carbon dioxide and this requires about 560 pounds of lime [$Ca(OH)_2$] per million gallons. If the free carbon dioxide is not all removed, part of the iron may be retained in solution as the bicarbonate and later be precipitated. With alum, the use of lime is not necessary when treating our hard waters since the presence of free carbon dioxide does not tend to retain the alum in solution. A little lime is helpful, at times, however, in speeding up the reaction.

Filtration as Applied to Water Plants

Filtration as applied to water plants may be divided into two heads, *viz.*, the slow sand or English type and the rapid sand or American type, also known as the mechanical type. The slow sand filter may be dismissed from the discussion as far as Iowa is concerned. The rapid sand plant uses coarser sand than the other type and depends for its success on the coagulum from the iron and lime or alum process depositing on the surface of the sand. A rapid sand filter may be readily cleared by reversing the flow of water and agitating the sand by rakes, air or by high velocity of wash water alone. Rapid sand filters are usually cleaned from one to three times a day. They should yield a clear water and should reduce the number of bacteria very considerably. Some color is also taken out. A late tendency has been to slight the operation of the filters and place most dependence on the treatment of the water after filtration by calcium hypochlorite or liquid chlorine. These two substances are efficient germicides and their use is universally recommended. They are not entirely satisfactory when used on turbid water containing considerable coloring matter, since the chemical is unable to reach bacteria imbedded in masses of suspended material. The use of more coagulant and more attention to the filtration of turbid waters is worth while. Chlorination alone should not be advised for a

water which is even slightly turbid, except in emergencies when nothing better is offered.

Iron Objectionable

Iron is objectionable in a water supply because it precipitates on standing, stains bath-room fixtures and white clothes, and tends to favor the growth of the iron-secreting organism crenothrix. This organism may grow so luxuriantly in the mains as to clog them. Iron is usually removed by filtration after precipitation by aeration or treatment with lime. Manganese, which sometimes accompanies iron, gives rise to similar difficulties. It is more difficult of removal. There is nothing definitely known which would lead us to believe that the mineral substances ordinarily found in our streams and wells are not healthful. A soft water may be preferred for drinking by many people; it is certainly more pleasant for washing purposes and more economical for industrial purposes, but there is no good reason to believe that it is necessarily more healthful for the normal individual than our ordinarily hard waters. It is the bacterial condition of the public water supply which is of the greatest importance from the health officer's viewpoint. He should know what the bacterial condition of the water really is. In cities and towns depending on the untreated water of wells for their supplies, changes in the quality of a water should be very slow. At times of unusually low water, or at times when a change in the character of the supply is apparent, examination of the water should be made, even though the water is examined at regular intervals once or twice a year. Where treated water supplies are used, it should be remembered that there may be considerable variation in the output of the plant from day to day. The operation is most likely to be unsatisfactory in the winter or in the very early spring. A turbid water coming from a water plant is usually a sign of improper operation, although it may be due to an after precipitation of iron. The chlorination process will not properly act on such water and the bacterial count is usually high. The cause will often be found to be cracks in a packed sand bed, insufficient chemicals or too little sedimentation.

Examination of Water Supplies

And now a few words with regard to the examination of water supplies as conducted by the Iowa State Board of Health Laboratories: All our work is directed toward an attempt to determine whether the water is contaminated or not, and if contaminated, whether or not the contamination is from sewage or sewage-like material. Of course, sewage is very likely to contain at any time the specific organisms of typhoid fever and similar diseases. If the bacteria of the disease are deposited in the water by a carrier or in the excreta from a case of the disease, the disease may be reproduced and an epidemic follow. We do not look for the typhoid organism itself, because it has not been found practical to do so. The organisms might die out before we received the sample of water, for one thing. Instead of looking for the typhoid bacillus we look for the colon bacillus, which is constantly present in the excreta of man and the warm-blooded animals.

Our chemical work we regard as subordinate to our bacteriological findings. The chemical substances determined are none of them important for their toxic actions in the quantities ordinarily present in contaminated waters. They aid us in forming an opinion of the history of the water, the density of the contamination and its source. In the chemical examination, most of the emphasis is put upon the determination of nitrogen in its various forms, because it happens that nitrogen is one of the substances most commonly present in organic matter. The albuminoid ammonia determination is intended to give us some notion of the amount of undecomposed organic matter present. Chlorine—by which we mean the combined chlorine of common salt and calcium and magnesium chlorides—may come from the soil or it may come from urine, and other wastes. If the nitrogen forms are high and chlorine is low, it may be said that in all probability the organic matter is the product of vegetable decay, while if chlorine is also high, the presence of decaying animal matter is indicated. In all cases where the collection of the sample is not made by a member of the staff, we must assume that the sample was collected and forwarded to us in the manner directed. We have carefully prepared a set of instructions which appear on our data sheet, but we know that sometimes they are neglected or not even read. Any contamination which is introduced will be to the disadvantage of the supply. In extreme cases it might even be erroneously condemned. Whenever we are led to believe that the sample has been accidentally contaminated, we explain this matter and request another sample for a re-examination. In a few States the ideal method of collection of samples by agents of the laboratory and sometimes plating in the field is practiced. The expense involved has prevented us from adopting this procedure, since the cost of collecting a single sample is considerable. Most of our communities were originally supplied with water by means of private wells, many of which remain in use at the present time or have been replaced by new wells, usually of the bored and driven types. Quite often an owner or a new tenant will have doubt as to the safety of one of these private wells. When convenient, the health officer can make a personal inspection of the well and its surroundings, and, if found advisable, an analysis may be recommended. Most board of health laboratories are glad to make examinations of private water supplies on the same basis as those for public use. It is recognized that an epidemic involving the neighborhood or even the entire community might have its origin in one of these private wells.

STREET CLEANING IN MONTREAL

"Far from satisfactory," says the Bureau of Municipal Research in its report to the Board of Control of Montreal, in commenting upon the results obtained by the street cleaning methods in vogue in that city. "This is due," claims the Bureau, "to the unpaved condition of many lanes and streets in the city, to the deplorable condition of a large part of the paved thoroughfares, and to the inadequate forces and equipment provided for street cleaning work.

"It is recognized that, during the period of the war, it may be advisable for the city to get along without spending more for street cleaning, but the following suggestions, if adopted, would promote cleaner streets without additional cost:

"Motor equipment, including flushers and the machine brooms recently purchased by the city, have developed certain defects that must be corrected. In particular, the larger machine brooms are ill-adapted for conditions in Montreal. These difficulties would indicate an error in judgment on the part of those ordering the above equipment, together with inadequate specifications that should be guarded against in the future. The more extensive use is advised of flushing methods in street cleaning and suitable equipment provided. The corporation of the tramways company should be ordered to extend the use of flushers."

CHAIN FENDERS IN THE LOCKS OF THE PANAMA CANAL*

By Henry Goldmark
Consulting Engineer, New York City.

WHEN the alternative plans for the Panama Canal were under discussion, advocates of the sea-level type laid great stress on the dangers to navigation inherent in a lock canal. Such dangers undoubtedly exist, although experience has shown that the risk of serious accident is very small in locks that are properly designed and carefully operated. Even at the Soo where the traffic, for many years, has been extremely heavy, only one serious accident is on record since the first lock was opened in 1855.

In comparing the two types in the case of Panama, it should be borne in mind that the broad and deep channels provided by Lake Gatun possess elements of safety which would have been absent in the smaller cross-sections of a sea-level canal.

On the other hand, the accidental destruction of certain of the lockgates would not only involve the risk of injury to vessels but might also set free the water impounded in Lake Gatun and lower its level so much as to stop navigation for a long period of time.

In working out the detailed plans of the locks, it was thought wise to take all possible precautions against injury to the gates and to provide special safeguards against further damage in case, after all, one or more gates were accidentally destroyed.

The safeguards adopted with these ends in view are the following:—

(1) Electric locomotives for towing all vessels through the locks. These travel on a rack railroad close to the edge of the lock walls and have, so far, proved entirely satisfactory in controlling vessels and keeping them centered in the lock chambers.

(2) Chain fenders for protecting the most important gates.

(3) Duplicate gates in certain parts of the locks. There are the usual "guard gates" at both ends of each lock flight and besides these a second pair of lower operating gates is provided in Pedro Miguel lock and the upper chamber at Gatun and Miraflores.

(4) Emergency dams of the drawbridge type at the upper end of each lock for shutting off the flow of water in case of serious injury to the gates.

The first of these devices forms a part of the machinery used in normal locking. As long as it functions properly no further safety mechanism comes into operation.

The second device, the chain fender, protects the gates when, for any reason, a vessel is not under the control of the towing system.

The third safeguard, the duplicate gate, in its turn, does not come into play until the fender protecting it has failed to fulfil its proper function, and finally,

The emergency dam is needed only after all the preceding safety appliances have failed so that it becomes necessary to check the current of water flowing through the locks.

A full description of the various safety appliances is given in a series of papers on the Panama Canal written by the members of the engineering staff responsible for the different parts of the work and presented to the International Engineering Congress at San Francisco in 1915. (Transactions of the International Engineering Congress, 1915. The Panama Canal Vol. II. Also published separately by the McGraw-Hill Publishing Co., New York, 1916.)

They are also described in a concise but readable and comprehensive article published in Engineering and Contracting, January 7th, 1914, which is the best general account of the Panama Canal known to the writer. Reference should also be made to an excellent paper ("First Year's Operation of the Locks of the Panama Canal," F. C. Clark and R. H. Whitehead. Journal of the Western Society of Engineers, Vol. xxi., No. 4, April, 1916), which records the experiences obtained in the actual operation of the locks since the opening of the canal.

The chain fenders, the second of the safeguards mentioned above, were adopted at the suggestion of the writer who was in immediate charge of their design and construction. While similar fenders have been used in English locks for a number of years, they are believed to be inferior in strength and reliability to the Panama design.

The fenders were placed in the upper and lower approaches to the lock flights, thus protecting the upper and lower guard gates, and also just above the intermediate and lower gates in the Pedro Miguel lock and the upper chamber at Gatun and Miraflores.

Description of Fender Machinery

The fenders consist of heavy chains, which normally span the lock chambers near the top, being lowered to the lock floor when a vessel is about to pass. Each gate and its protecting fender are interlocked electrically, so that the chain cannot be lowered until the gate is opened, and hence is no longer in danger from collision.

The chain is arranged to pay out under stress when it is struck by a vessel, so that the energy of the vessel is absorbed and it is brought to rest without damage. The machinery must, therefore, not only make provision for lowering and raising the chain in daily operation but must also include some reliable means of putting the chain under stress when it is stopping a vessel. Evidently the success of the entire fender depends upon the mechanism for producing a suitable resistance to the travel of the chain in its emergency action.

In the English fenders, mentioned above, the friction of the chain about a horizontal cast-iron cylinder placed on one of the lock walls, is depended upon to give the necessary resistance. A small hoisting engine on the other wall raises and lowers the chain.

The writer examined one of these fenders at Avonmouth, near Bristol, in 1908, and discussed their details with the designers and builders, Messrs. Brown, Lenox & Co., of Pontypridd, Wales. They are simple in construction but the frictional resistance is likely to be variable in amount. It is also believed that lowering the chain from one end only is undesirable, as it often forms a loop at the bottom which may foul vessels in the lock. As far as could be learned, no tests in actually stopping vessels have ever been made with these fenders.

It is proper to add that the Panama designs were well in hand before the writer had heard of the English fenders, although their inspection proved of much interest. He would also like to record here his indebtedness to his friend, E. H. McHenry, M.Can.Soc.C.E., for most valuable suggestions in connection with the first inception of the Panama chains.

The adopted design was the result of an extended investigation. Frictional resistance of different kinds were studied, also the use of heavy weights for stopping the

*Abstracted from paper on tests of these fenders, presented to the Canadian Society of Civil Engineers.

vessels, but the hydraulic apparatus finally selected was considered to have advantages over all other forms.

In each of the twenty-four fenders built at Panama, there are three cylinders of the plunger type, the upper of which is suspended from beams spanning the machine pit while the bottom plunger rests directly on the concrete. The intermediate cylinder is movable, and slides on the inner surface of the upper and the outer surface of the lower cylinder. The chain passes through a hawse-pipe casting of steel, secured to a heavy anchorage, and is connected to the moving cylinder by a system of grooved sheaves. The pull of the chain when stopping a vessel is transferred to the anchors embedded in the concrete.

The lowering and raising of the chain is brought about by pumping water under pressure into the bottom and top cylinders respectively. The maximum stroke is 21 ft. 3 ins. and the multiplication given by the sheaves is fourfold, so that the chain pays out 85 ft. from each wall, a length which is sufficient for the deepest lock and also provides ample stopping power in emergency operation.

The chains were made from wrought iron bars 3 ins. in diameter and have links 10 ins. wide and 17 ins. long. The sections spanning the lock chamber have standard Navy stud links, while open links are used for the part that passes around the sheaves. Considerable difficulty was met with in obtaining chains of proper strength, especially the open links which have rarely been made of so large a size. The specified breaking strength was 500,000 lbs. for the studded and 450,000 lbs. for the open links, but all shots of chain were subjected to proof tests of 300,000 lbs. and 250,000 lbs. respectively.

In order to start the cylinder on either the upward or downward stroke, it is necessary to start the centrifugal pump and also to reverse the position of the operating valve which controls the direction of the flow. The latter is of the double piston type and operated by a small electric motor. Both the pump and valve motors are normally started from the central control house, from which all the gate and valve machines in the lock flight are controlled, but local control is also provided for.

The cylinder is brought to rest at each end of the stroke by a limit switch which stops the pump automatically, and it also starts the same whenever leakage has caused the cylinder to move up or down a predetermined distance from its end position.

The maximum pressure in the cylinders is from 100 to 150 lbs. per square inch, the higher pressure being required in lowering the chain as the heavy intermediate cylinder has to be lifted in this case. The high pressure prevails in the upper cylinder when raising and the lower cylinder when lowering the chain.

The pump has two stages, the first being of the volute, the second of the turbine type, a somewhat novel arrangement, which has proved entirely satisfactory. The pump has a 6-in. suction and 5-in. discharge pipe and is operated at 460 r.p.m. by a 70-h.p., 250-volt, 25-cycle induction motor. The lowering or raising of the chain is done in about one minute in a perfectly satisfactory manner, the chain dropping into a pit in the floor so as to offer no obstruction to the passage of vessels.

Emergency Operation

As the sole function of the fender is the checking of vessels, the device for maintaining a heavy tension on the chain, as it pays out, after being struck, is the most vital part of the entire apparatus.

It consists of a pair of resistance or relief valves. When the chain is struck by a vessel, there is a tendency for the moving cylinder to rise, so that the water pressure in the piping increases rapidly. The resistance valves must permit the water to escape, as soon as the pressure reaches a point corresponding to a suitable working tension in the chain links and then keep the pressure as nearly constant as possible. As a rule it will be necessary, in order to accomplish this result, for the opening in the valves to vary slightly as the chain pays out. Their movement must, of course, be reliable and they must close promptly when the strain on the chain is entirely relieved.

It should be noted that the travel of the chain is resisted not only by the hydraulic resistance to the motion of the cylinder but also by the weight of the cylinder and other moving parts, by the friction of the chain at the hawse-pipe casting, as well as by frictional resistance in the machinery itself. It proved entirely feasible to measure these supplemental forces accurately. They proved about equal in amount to the internal hydraulic resistance, making it necessary to set the valves which control the pressure in the cylinder for a much lower pressure than originally contemplated.

With the chain in its normal operating condition across the top of the lock, all gate and check valves are closed, so that the resistance valves provide the only means by which the pressure can be relieved.

In view of the importance of the subject, various types of valves that seemed suitable for the purpose were carefully studied and three different designs were finally selected for detailed tests. The tests were very carefully made, with delicate apparatus, so that they may be called laboratory experiments on a large scale. There were three series of tests:—

(1) Preliminary tests on the three valves at a large pumping plant in the United States, which provided water under high pressure.

(2) Tests made on the first fender machine erected in Gatun Lock, the chain being put into tension by a large winding engine.

(3) Actual working tests of one of the Gatun fenders in stopping large vessels.

Tests in Stopping Vessels

The first two tests gave a reasonable assurance that the fenders would function properly in stopping vessels. Twenty-two of the fenders were therefore built, practically identical in plan, while two others (in the lower approach to Miraflores Lock) differ only in having two chains stretched across the lock at different levels, to provide for the great difference (22 ft.) between high and low tides in the Pacific. Their machinery is absolutely identical with that in the other fenders, the high and low level chains being alternately connected and detached, as the tide changes.

It was, of course, desirable to make an actual test of the fenders in checking a vessel in the lock. In October and November, 1915, after the writer had left the Isthmus, a number of such tests were therefore made by a board appointed by the governor of the canal. They proved of great interest and value especially as the vessels were of considerable size. Two ships were used, the "Allianca," having at the time a displacement of 4,221 tons, and moving at speeds varying from 1.23 to 3.38 miles per hour, and the "Cristobal," with a displacement of 18,000 tons and speeds as high as 2.45 miles per hour.

The resistance valves were set to open at 360 lbs. per square inch in most of the tests, and the propellers of the vessels were stopped in every case before the chain was struck. Indicators were connected to the piping system

in the machinery rooms and the pressures and also the travel of the moving cylinder of the machines were automatically recorded.

A rope mat was woven around the central portion of the chain and a similar protection given to the stem of the ship. No damage to the ships occurred as a result of the tests, and the chain was marred only very slightly. Twelve runs were made with the "Allianca" and ten with the "Cristobal," and the vessel was brought to a stop in every case before the chain had paid out to its extreme limit.

The tests with the "Allianca" were not entirely satisfactory, as the resistance valves had not been cleaned for a long time, and there was a slight sticking of the valves which prevented them from closing promptly when the pressure was reduced. All the valves were, therefore, thoroughly cleaned, a new leather placed in one valve, and the other leathers softened up. The tests with the "Cristobal" were made after these changes were made, and proved entirely satisfactory.

The pressure curves have a decided peak at the beginning, which is in every case decidedly above the setting of the resistance valve. Beyond this point, and throughout the greater part of the stroke the pressure remains remarkably uniform, with very few oscillations. The vessel was brought to rest from 51.5 to 62.0 ft. beyond the centre of the fender machines, its speed when striking the chain being from 2.06 to 2.45 miles per hour.

There was little difference between the pressures in the machines on the two lockwalls or in the length of chain paid out from each side. The travel of the cylinders was hardly over 6 ft. out of a total possible stroke of 21.5 ft.

The distance travelled by the ship before being stopped was less than the shortest distance from any of the fenders to the gate it is intended to safeguard, so that there seems to be every assurance that the fenders, if ever called upon, would fulfil their purpose, even in the case of a ship as large as the "Cristobal" and moving at a speed of over 2 miles per hour. As this vessel is about 500 ft. long, and 58 ft. wide, few larger ships are likely to use the canal, nor is the speed of two miles likely to be exceeded in the approaches or the locks.

The distance in which the "Cristobal" was stopped agrees very closely with the theoretical curves which were computed before the designs were completed, but after the working stress of 220,000 lbs. had been adopted for the chain in stopping vessels. These curves are shown in the Annual Report of the Isthmian Canal Commission for 1911. This close agreement with theory is, of course, very satisfactory. Accounts of the various tests are given in the Annual Reports for 1913, 1914 and 1916.

CORRECTION

On page 150 in our issue of February 21st, in the article on "Water Supply and Sewer System for Cap de la Madeleine," by Romeo Morrissette, of Three Rivers, P.Q., it was stated that the sides and bottom of the reservoir were constructed of 1:2:4 concrete, 2 ft. thick, covered by a 3-inch layer of waterproofing grout of the same proportions, "to which," said Mr. Morrissette, "was added 10 per cent. of Toch cement." This should have read "2 per cent. of Toxement," as Toxement is the trade name of the concrete waterproofing made by Toch Bros., and it was found necessary to add only 2 per cent. of it, not 10 per cent., to obtain the desired results.

AVAILABILITY OF ENERGY FOR POWER AND HEAT*

By John Blizard, A.M.Can.Soc.C.E.
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THE source of all our useful energy is the sun, which continues to supply us with food, fuel, rain, wind, and radiant heat, and has stored up for us in the past vast quantities of vegetable matter since converted into valuable fuels. The forms of energy available for conversion into power and heat are: Water power, wind power, sun power, natural gas, oil, wood, peat, lignite and coal. The cost of converting any one of them as found in nature into a specific quantity of the form of required energy at the particular place required is a measure of its availability. It will depend upon the cost of winning and transportation or harnessing, the cost of conversion, and the cost of transmission.

The cost of winning and transportation applies to the fuels, and is summed up by their price as delivered at the place of conversion. The cost of harnessing refers to expenses, such as those involved in developing a water-power site. The cost of conversion applies to all, and its consideration involves an inquiry into the law of conversion. In its simplest form, this law states that any of the forms of energy may be converted into heat; but that the conversion of heat into work is never the sole result of a natural process. Thus, since the production of work by fuel involves the generation of heat, the best overall efficiencies of coal steam electric generating stations are of the order of only 18 per cent. But the overall efficiency of a hydro-electric station may reach 80 per cent. If, however, a fuel be used to generate thermal energy, as in a steam boiler, it is possible to recover 80 per cent. of its energy. Thus the development of water powers for heating processes which the combustion of fuel will perform with equal efficiency is a degradation of energy. For special electro-thermal processes it is economical to use water power for heating; but they are exceptional, and practically all thermal processes should make use of fuels. For the same reason, wind and water power should not develop heat energy. Unfortunately, wind power is available only for small powers, while the cost of development and situation of water powers make it necessary to use fuels for the generation of most of the world's power supply.

The actual efficiency of conversion of the energy in fuels into mechanical or electrical energy varies considerably. It depends upon the class of fuel and the heat engine. Thus, the best thermal efficiency to be obtained with a steam turbine is about 26 per cent., and with the gas engine about 35 per cent. But the thermal efficiency is not the sole criterion of the cost of conversion, for the costs of the installation are an important factor. And the steam turbine, with its higher heat consumption, is able to compete with and outdistance its competitors for large stations, because of the much lower investment costs.

The energy of a fuel is invariably released eventually in the form of heat. But it is frequently converted into other modifications of fuel. A most important example of this type of conversion is the carbonization of coal, by which not only gaseous liquid and solid fuels are produced but numerous and valuable by-products.

The cost of transmission of energy will depend upon the class of energy transmitted, its price per unit, and the

*Paper read before the Ottawa Branch of the Canadian Society of Civil Engineers, February 28th, 1918.

distance transmitted. Thus, it is economically possible to transmit electrical energy to great distances, gas of high calorific value to comparatively long distances, low calorific value gas to shorter distances, and steam or hot water only in the vicinity of the plant.

It is obviously of great importance to the community as a whole to see that all forms of energy serve in the best way the purpose for which they are most available. To choose energy and means of using it for a particular purpose is not simple. Thus, energy for road transportation may involve a comparison between oats and gasoline; and horses and heat engines. For a mill with a high load factor the issue may be between the Diesel engine and water power; while for a poor load-factor the steam turbine plant alone may be worth considering.

It may appear at first sight that, since sellers and users of energy sell, generate, or buy to the best advantage to themselves, things will be adjusted so that energy is used in the most economical manner. This is true for the most part. But they are compelled to use only the available forms of energy, and to convert them into the required form in the apparatus which manufacturers supply. To better these conditions, three things are necessary: First, it is necessary to examine the whole community's requirements; secondly, to take stock of the sources of energy, and thirdly, to see how they may meet the requirements to the best advantage.

An inquiry into these three subjects would be of great breadth, depth, and variety. Once completed, it would be of very great value. Constant change in a country's development and its methods of generating heat and power would necessitate its frequent revision. But until such an inquiry is being prosecuted continuously with great vigor, both in the field of commercial use and development, and in laboratories independent of private interests, a country will be at a disadvantage.

It is proposed here to outline the sources whence we in Canada receive our supplies of energy, and the requirements they meet.

Coal is of first importance. In the course of a year we burn 30 million tons, of which 60 per cent. comes from the United States. The remainder is mined in Canada.

Practically no coal supplies exist between the provinces of New Brunswick and Saskatchewan, and the combined output of these two provinces amounts to only 4 per cent. of the country's production. One-half of the remaining 96 per cent. is mined in Nova Scotia, and the other half is mined in the provinces of Alberta and British Columbia. The coal reserves of Canada are enormous, and we may rely on a continuance of native supply for a very long period of years. Whether we may place equal reliance on our supply from the United States or not is uncertain. The present shortage seems to be due to abnormal difficulties of transportation rather than those of production. It is certain, however, that the supply of anthracite from that country will decrease, and that the time is not far distant when they will come to us for their supply of coke or coking coals.

A part of the annual coal consumption is accounted for as follows:—

Manufacture of coke	2,000,000 tons
Railway locomotives	9,000,000 "
Collieries	1,000,000 "
Bunkering ships	1,000,000 "

The remaining 17 million tons are used for domestic and general manufacturing purposes. An approximate estimate of its subdivision is: 5 million tons for domestic heating, 6 million for industrial heating, and 6 million for industrial power.

Assuming that the colliery consumption is for power purposes only, and that 7 pounds of coal generates a horse-power hour, the total mean continuous applied horse-power in Canada derived from coal is 500,000, of which locomotives develop 300,000.

Water power is used for the most part to supply mechanical and electrical energy. About 2 million horse-power has, so far, been developed. The total available horse-power is estimated at about 18 millions, of which 8 million is estimated to be available within the present range of markets. An additional development of 6 million horse-power, assuming an efficiency of conversion of 60 per cent., and a plant factor of 40 per cent., would supply about 1½ million horse-power continuously. This is much more than sufficient to supply that generated yearly by our 16 million tons of coal.

Wood is a very important Canadian fuel. The estimated value of firewood used during 1916 was 62 million dollars, or more than the value of our coal imports. Although, to some extent, its use may be for power generation, principally in log-product factories, it is probable that most of it is used for domestic purposes. It is not likely that it will, to any extent, be able to take the place of other forms of energy, except spasmodically, as in times of an acute scarcity; nor is it likely that other forms of energy will take its place.

Oil and natural gas occupy an inconspicuous position compared with wood, coal and water power.

The annual oil consumption is about 250 million gallons, and practically all of it is imported. It is in a more available form for the generation of power and heat than any other fuel. While not impossible to replace it with other forms of energy for small gasoline and kerosene engines, such a change could be effected only with great inconvenience. In addition to its use for these purposes, crude oil in large quantities is used, particularly in the West, for railways, ships, and industries. Altogether, at least 100 million gallons are burned under steam boilers.

Van H. Manning, director of the United States Bureau of Mines, in reviewing the oil situation of that country, estimates that its supply at the present rate of usage will last only 25 years. He further remarks that petroleum should be used neither for gas manufacture nor for fuel under boilers, nor in any way to compete with coal. It would appear, then, that we must soon find another source of supply. This may come from the known shale deposits of Canada or the United States, or, possibly, from the vast unexplored areas in the west of Canada. The distillation of oil shales would not be a new venture, since, in Scotland, 3 million tons are produced annually, giving about 20 gallons of oil to the ton. Another source of oil is tar obtained from the distillation of coal and lignite. Benzol, another coal distillation product, is an excellent motor spirit, though, to counteract its tendency to freeze at only fairly low temperatures, it is necessary to mix it with alcohol or gasoline. Still another coal by-product, naphthalene, may be used for explosion motors.

There is no doubt that alcohol is destined eventually to become prominent as a motor spirit. It is of particular importance, since it may be obtained from vegetation, and is thus independent of the stored sources of energy.

Natural gas is used in particular districts adjacent to the gas fields. Its high calorific value, nearly twice that of coal gas, renders its distribution over a large area economically possible. The annual consumption in Canada is about 20 million thousand cubic feet. It is used for

industrial and domestic purposes. Since it is in a form more available for the generation of power than any solid fuel, it is advantageous to use it for this purpose whenever possible instead of coal.

Peat contributes practically nothing to our energy requirement. Yet it exists in large quantities throughout the Dominion, and in view of its success as a fuel in other countries, and the information obtained from its manufacture and use here, its availability for the generation of power and heat is known. It is impossible to believe that there is no field for its exploitation and it must be expected soon to find a position as a source of heat and power.

This faint outline of our requirements and sources of energy does not afford information sufficient for proceeding with an inquiry which will lead to the connection of the user of power and heat with the most available form of energy. Here the possibilities of increasing the availability of our supplies of energy will be considered with reference to special methods. They will refer only to the establishment of central stations for the use of the solid fuels, and to the possibility of using hydro-electric energy for house heating.

Central Stations

The central station may be designed to supply electrical energy, gas, steam, liquid fuel, solid fuel, and various by-products, many of which have no connection with the generation of energy. The economy of operation depends upon many factors; one of the most important of which is a large system in which there is more complete utilization of the full capacity of the plant. This is due to non-coincidence of the maximum loads of the various consumers, better thermal efficiency of conversion due to the use of larger units, more complete and intelligent supervision and design, and to the possibility of operating for longer periods at the more economical rated load. The limit of the central station's sphere is reached, when it is cheaper to haul the fuel to the consumer than to deliver energy through pipes or along a wire. It varies with local conditions and the type and price of the fuel. It will be greater for low-grade than high-grade raw fuel, since costs of transportation vary with quantity and are independent of energy content.

The largest field for the central station will be in the generation and distribution of electrical energy. The rough estimate of the mean present power load now met by coal showed the very large requirement of locomotives. To replace the uneconomical steam locomotive with the electric locomotive seems at first sight a rational project. Where the substitution has taken place the coal consumption in the central steam electric stations is one-half of the former consumption on the locomotive. There could be no objection to its substitution for oil in forest areas, and the present damage from locomotive soot and sparks would cease. An examination of the roads electrified shows that they are confined for the most part to suburban and mountain traffic. But the electrically equipped mileage is increasing, and the continuous increase in the price of coal brings the day of general electrification nearer.

The remaining power, which is used for general industrial purposes, is in itself of magnitude sufficient to warrant the consideration of central station supply. Whenever external electric supply takes the place of energy generated at the plant itself, economy results. In many districts this change has resulted in reducing the coal consumption to one-quarter of its previous magnitude.

Central stations distributing gas have not so promising a field as those distributing electrical energy. The costs of transmission, and the relatively high efficiency of conversion of coal into heat energy in the plant itself reduces the possible gain to the buyer. Nor is it likely that the substitution of this type of plant would save fuel. Nevertheless, the cleanliness and improved availability of gas as compared with coal would frequently lead to its preference by consumers.

Types of Central Stations

Central stations may be of the following four types:—

(*a*) Those in which the fuel is completely gasified by partial combustion, and the energy distributed either as gas or electrical power.

(*b*) Those in which the fuel is carbonized and energy distributed in the form of solid fuel, and gas or electricity.

(*c*) Those in which the fuel is completely burned and electrical energy and steam distributed.

(*d*) Those in which fuel is completely burned and electrical energy only distributed.

A consideration of these stations follows:—

(*a*) The by-product recovery producer plant is the most promising means of totally converting solid fuel into gas. Its economic importance lies largely in the high returns possible by the recovery of from 60 to 70 per cent. of the nitrogen in the fuel in the form of sulphate of ammonia. It is of great value for the exploitation of low-grade fuels, particularly peat, whose nitrogen content is high compared with its calorific value. The gas produced has a heat content of about one-fourth that of coal gas. It may be distributed to consumers, or partially converted into electrical energy by use of gas engines or boilers and steam turbines.

In south Staffordshire, a plant has been in operation for some years, and supplies gas over an area of 123 square miles. The price paid for the gas varies from 3 to 5½ cents per thousand cubic feet. The fuel used is slack coal of a fairly low calorific value. This is the only plant which distributes producer gas on a large scale, and it is noteworthy as a possible reason for its unique position, that no dividends have been paid for some years.

In Italy two by-product plants, using peat, are in operation. The energy is distributed electrically.

(*b*) The two outstanding objects of carbonizing coal are to obtain a maximum yield of either coke suitable for metallurgical purposes or of gas suitable for domestic purposes.

The first method of carbonizing is carried out in coke ovens, wherein the long time of carbonization, large size of charge and compression give a coke of the requisite great density and hardness. It is possible with modern coke ovens to obtain a yield of gas more than sufficient for heating the charge, about 20 per cent. of the nitrogen in the coal as ammonia in addition to light oils and tar. The surplus gas is usually of only slightly lower calorific value than town gas, and is eminently suited for distribution for general use, or may be used as a fuel at the plant for the generation of electrical energy.

The second method of carbonization differs from the first in that smaller charges are used in order to obtain the necessary quality and quantity of gas, none of which is used for heating the retorts. As with coke ovens, coke, ammonia, benzol, and tar are recovered as by-products from retorting coal. The yield of coke, however, is less and some of it is used for heating the retorts, while the ammonia yield is greater, due to the smaller contact with the smaller charge.

The coke obtained from retorting the gas is soft and loose in structure, and may be used in domestic furnaces; its disadvantages for this purpose are its bulk—which necessitates more frequent firing than with coal and larger storage space—and its tendency to clinker.

The choice of installing coke ovens or gas-making retorts, both of which require much the same class of coal, obviously depends upon the possible market for the products. The development of a domestic fuel trade in the soft coke is possible, if a suitable market can be found for the gas. Metallurgical coke, on the other hand, is not so suitable for domestic purposes, since it is very hard, difficult to ignite, and requires a strong draft to burn it. Nevertheless, it may prove a valuable and economical substitute for anthracite coal, if sold at a reasonable price.

(*c*) The third type of station represents the most economical means of generating power where coal is reasonably cheap and all the exhaust steam may be used for heating. The prime mover may be either a steam engine or steam turbine of a comparatively cheap type, and no condenser is required since the power may be looked upon as the by-product and the steam as the most valuable product. It is not possible frequently, however, to find useful employment within a small area for the exhaust steam, and heat losses prevent the transmission of thermal energy in the form of steam or hot water over a large area. On the other hand, it may prove feasible to generate power in plants where a heating load exists and transmit electrical energy to customers in the neighborhood.

(*d*) This is the most popular type of power plant, and in large sizes consists of boilers, turbo generators and condensers. It is too well known to need description; but it is interesting to note that steam turbines are made of 70,000 kilowatt capacity, and operate with steam pressures and temperatures as high as 350 pounds per square inch and 690° F.

Each of these stations has a field of use. To say what field, without more information, would be mere speculation.

Hydro-Electric Energy for House Heating

There is a prevalent notion in the public mind that the country should settle once for all the difficulties and inconvenience of securing and burning coal for heating houses by developing and using water-powers for this purpose.

At first sight it seems reasonable to reduce the consumption of our transitory possessions, the fuels, by using a continuous source of energy, which is at present going to waste. It is pleasant to contemplate the substitution of the cheerful electric radiator and switch for the complications of the present system. But the substitution by this method is based on a wrong principle.

Recurrence to the previous remarks on the laws of conversion of energy will show that the conversion of electrical energy into heat, as when a current flows along a conductor, is a degradation of energy. To use this highly available form of energy for a simple thermal process can only be taken as a confession of lack of resourcefulness to provide a more suitable load.

To emphasize the misuse of electrical energy by direct degradation into thermal energy, it is proposed to see how its availability may be put to proper use for the purpose served by the direct radiator. The result, which follows from a suggestion of Lord Kelvin in 1852, will be surprising; for it will show that it is possible to render more kilowatt hours available for heating the house than would be registered by the wattmeter. The method is to use the electrical energy to drive a heat pump. That is to say, the energy delivered to the house is the sum of the electrical energy and the energy obtained from a cold source. Supposing a reversible engine, the supply of heat from the freezing of water, and the temperature of delivery as 155° F.; for every kilowatt hour paid for, 5 kilowatt hours would be delivered to the system. Since no actual engine is absolutely reversible the efficiency would be less than that shown, but even supposing only 2 kilowatt hours per kilowatt hour to be possible, it is clear that use of the thermodynamically irreversible radiator, when the partially reversible heat pump is much more efficient, would be a waste of energy.

Were the domestic heating load constant or nearly so throughout the year, it might be profitable to examine the practicability of this scheme. But the ratio of maximum to minimum load is higher than would allow of a rational diversion of hydro-electric energy for this purpose.

Conclusion

In conclusion it is pertinent to point out that an engineer introduced the present age of energy. It came with Watt's invention of a steam engine, and with it began the slow and sure depletion of our stores of energy. It is for the engineer to prolong this age. He must not fail to draw energy from the right source, through the best channels and use it with a minimum loss. And there is ever before him an immeasurably greater question. It is the consideration of the availability of the natural continuous supply of energy for the generation of the world's requirements of heat and power.

MONTREAL BRANCH, CAN. SOC. C.E.

Following is a list of nominees for office in the Montreal Branch of the Canadian Society of Civil Engineers:—

For chairman—Sir Alexander Bertram, Walter J. Francis, R. M. Hannaford; one to be elected.

For vice-chairman—J. A. M. Duchastel, Arthur Surveyer, R. M. Wilson; one to be elected.

For secretary-treasurer—Frederick B. Brown, Harry M. Lamb; one to be elected.

For committee—M. B. Atkinson, John S. Bates, J. A. Burnett, A. Crumpton, A. Frigon, H. G. Hunter, A. E. Johnson, W. D. Lawrence, O. Lefebvre, J. W. Orrock, L. G. Papineau, P. L. Pratley, Stewart Rutherford, J. A. Shaw, F. P. Shearwood, A. D. Swan, W. Chase Thomson, K. B. Thornton; six to be elected.

These nominations were presented by the nominating committee at a meeting of the branch held on February 28th, and have been sent out to members in the form of a letter ballot.

WILL ORGANIZE HALIFAX BRANCH

The establishment of a Halifax Branch of the Canadian Society of Civil Engineers has been approved by the Council of the society and it is expected that arrangements will be completed at an early date. The secretary of the society has been delegated by the council to go to Halifax for that purpose.

The Engineers' Section of the Ontario Municipal Electrical Association will hold its semi-annual meeting March 13th and 14th. The meeting will be held in Room C. 26, Chemistry and Mining Building, University of Toronto.

INCREASED CANADIAN STEEL PRODUCTION

In a recent issue of The Wall Street Journal is contained a quotation from a business man of excellent judgment, who says that those in the United States reckoning upon a large sale of steel and iron products to Great Britain and to other European countries after the war is ended are in error. For it is asserted that Great Britain, Canada and Germany have greatly enlarged their steel-producing capacity; they have, in addition learned economy and efficiency. Furthermore, the Wall Street Journal says that the prevailing opinion that after the war is ended we shall be found leading the world in our exports of steel and iron products, is not taken seriously by steel men, who have watched the development of the steel industry since the beginning of the war.

Will Not Buy Heavily

One of the reasons given by the authority which the newspaper quotes for his belief that European countries will not buy heavily of steel and iron from the United States after the war, is to be found in the fact that these countries will then be debtor nations, possibly by as much as $100,000,000,000. They certainly will owe the United States many billions—in fact they do now. Therefore, they will not be disposed to increase their indebtedness by making heavy purchases of steel and iron in the United States. Instead of that the manufacturers will strain themselves to the utmost to command the greater part of the steel and iron trade of the world. For in that way they will be able to secure some part of the funds by which they may meet their obligations. They will make a great drive against the United States; they will attempt successfully to compete in our own markets with American iron and steel manufacturers They will rely to some extent for success upon high cost of production of steel and iron in the United States, due chiefly to the wages and salaries which are paid to the artisans.

Discussing these statements, "Holland," in an article in the Wall Street Journal, says that undoubtedly the view set forth by this authority is the one taken by the leaders of the steel and iron industry, yet with a mental reservation. These leaders believe that we can hold and increase our world trade in steel and iron products, notwithstanding the high cost of labor, if there be satisfactory legislation, part of it so enacted as to prevent the dumping into the United States of steel and iron products and part of it so enacted as to enable us with facility and at reasonably low cost to approach the markets of the world.

On the office wall of one of the high executive officers of the United States Steel Corporation is conspicuously placed a legend reading as follows: "In time of war, we should prepare for peace." Undoubtedly, the managers of the Steel Corporation and, in fact, the managers of all the independent steel and iron industries of the United States, are now, as far as possible, preparing for conditions which will arise immediately after the war is ended They hope to secure the passage of an act which will enable steel and iron manufacturers who are exporters, to act in co-operation and in combination, so far as foreign markets are concerned. Action of that kind was one of the reasons why Germany was able to secure rapidly a considerable share of the world's trade in the iron and steel products. Then, again, these industrial leaders hope that after the war is ended they will have available a large amount of ships. Lack of shipping facilities was one of the reasons why the iron and steel makers of the United States were not able always to compete with the Germans and the English manufacturers of iron and steel.

Furthermore, it is hoped that legislation, which will modify the existing anti-trust laws, will be enacted. For if, for instance, the United States Steel Corporation should be dissolved through the judgment of the Supreme Court upon the action now pending, then it is inevitable that the United States will lose a large part of her exports of iron and steel products.

France and Belgium

Apparently the managers of the United States iron and steel industries do not now contemplate entering the markets of Great Britain or of Germany with their products after the war. They do believe that France and Belgium, if Belgium is quickened, will become heavy purchasers of American iron and steel products, provided conditions as well as legislation are favorable They look for great markets in South America and in the Far East, and if they are not handicapped by unfavorable conditions or by stringent legislation they believe that they will be able to meet whatever competition Great Britain or Germany, should Germany try to compete, may offer in the South American and Far Eastern markets. They are not concerned about the high cost of labor, for they believe this is offset by the greater productive capacity of highly-paid labor, by the utilization of the best labor-saving machinery, by the employment of highly competent men of science, and also by our favorable situation with regard to coal and iron deposits.

This is the contingency which the industrial leaders, whose achievements since the war began in iron and steel commodities, have been noteworthy, hold in reserve while they are disposed to admit that Great Britain and the European nations will not only refrain from purchasing American iron and steel, but will also attempt to dump enormous amounts of these commodities into the United States. The British manufacturers may be able to do this unless the United States manufacturers are favored by legislation and are aided by such facilities as, for instance, the proposed foreign commerce bank would offer. Given fairly even conditions the American manufacturers believe that they can not only hold the trade they have already secured but can increase it, no matter what competition Great Britain and Germany may offer.

C.N.R. EQUIPMENT WOULD YIELD PROFITS

The proceedings of the board of arbitration, sitting at Osgoode Hall to hear evidence as to the value of the Canadian Northern Railway stock, on February 14th were enlivened by a debate between members of the board as to the feasibility of W. H. Coverdale's plan for extensions to the Canadian Northern Railway system in mileage and equipment, which, he declared, if put into execution, would result in practically doubling the earning capacity of the railway. Mr. Coverdale is the New York consulting engineer who examined the Canadian Northern Railway system and finances for the purpose of the Loomis-Platten report, and his programme of betterments involves the expenditure, before 1923, of a sum approximating $80,000,000. With this expenditure allocated as he suggests, he estimates that gross earnings standing at $35,476,000, as on June 30th, 1916, would be increased to $80,320,000, with a surplus over expenses of $4,615,000 by 1923. Mr. Coverdale declared that his estimate of increases in earnings was conservative, and pointed to the fact that for the 1917 period the railway had actually exceeded the amount estimated by $2,000,000.

The point of contention between members of the board was as to the possibility of finding the funds to pay for the betterments. Mr. Justice Harris expressed an opinion that no sane man would attempt such a programme of expenditures under present conditions, as he believed it would be impossible to get the money. Counsel for Mackenzie and Mann contended that the expenditures were vital and must be made if the railway is to continue its existence as a going concern. Sir William Meredith then broke into the argument in support of Justice Harris, and declared that the minister of finance had intimated that he would not put a dollar into additional expenditures on capital account. Wallace Nesbitt, K.C., disagreed with the chairman, and declared that the money would be available if the proposals proved to be sound.

The Brantford, Ont., city council has approved the purchase of the toll roads of Brant for $28,000.

One feature of the coming annual general meeting of the Institute of Metals will be the display of cinema films of the Canadian water powers.

A deputation from the Lincoln County Council has asked that the Provincial Government take over the Queenston-Grimsby road as part of the provincial highway system.

To-day at a luncheon meeting of the Ottawa Branch of the Canadian Society of Civil Engineers, Hon. F. B. Carvell, Minister of Public Works, is to speak on "Some Phases of the Relation of the Engineer to National Life."

"It is hardly likely that I would be guilty of making such a silly proposition," was the comment of Lord Shaughnessy, president of the Canadian Pacific Railway, when his attention was directed to rumors which announced that the company would dispose of the railroad to the government. The rumors intimated that the shareholders would retain the hotels, steamships and land of the company and expect a guaranteed dividend of 7 per cent.

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Principal Contents of this Issue

GUARANTEE BONDS

A treasury board regulation prevents the acceptance of anything but a cash security in connection with contracts for the Public Works Department of Canada. This department cannot accept a guarantee bond, an instrument which has become an important factor in modern business. Considerable inconvenience is caused to contractors and others by the requirement of substantial cash security for the performance of certain work. Large sums of cash deposits lie idle when they might be employed profitably. The majority of public bodies in Canada are satisfied with the guarantee bond, furnished by reputable companies which make a specialty of the business, and which bond provides security for performance of contract. What is the reason for the treasury board's regulation?

WAR TRADE BOARD

The appointment by the Dominion government of a War Trade Board is a commendable step. One of the few criticisms that might reasonably be offered is that the creation of the organization was delayed too long. The personnel of the board combines many qualities and experiences which will be of great value in the important work ahead. The board is representative not only of departmental experience, but also of practical industrial, financial, labor, and executive experience. It might perhaps be strengthened by the addition of engineering advisers.

The powers and duties of the board, which were outlined in the February 14th issue of this paper, are very wide. The organization will have direction of licenses for export and import. They may supervise when necessary, industrial and commercial enterprises with a view to preventing waste of labor, raw materials, and products. They will make recommendations for the maintenance of the more essential industries and will also investigate the country's stock of raw materials, partly finished and finished products and, when necessary, direct their distribution. In addition, they will co-operate with the Canadian War Mission at Washington which, by the way, might profitably have been appointed many months ago, instead of in the early part of 1918. The board naturally will co-operate with the several departments of the government.

Our War Trade Board has been constituted, as the prime minister has stated, "following very careful consideration of more effective organization for the purpose of the war, and having regard to the necessity of more effective measures for maintenance of industries essential for that purpose."

ARE ENGINEERS NARROW-MINDED?

Not so much for any valuable ideas which it contains, but more as an example of the glittering generalities which many magazines are to-day printing about engineers and their work, we reproduce the following from the December issue of Industrial Management, New York:

"Engineers are steadily moving into the forefront of the professions. This enviable position was once held by the clergy, then by the law, and then by medicine. Engineers now are having their turn—or soon will be having it. It is a responsible place in society. To lead, to guide—that is it. Therefore, bearing this tremendous responsibility, engineers should live cheek to jowl and elbow to elbow with society. Engineers should understand humanity—its foibles, its weaknesses, its governing sciences. Men in the profession should know something besides laws which have nothing to do with society as such. Mathematics never bred cats, for instance—though mathematics might at times be strained to keep count of the kittens; nor has chemistry or physics ever accounted for John's red hair, when John's father and mother both have raven locks.

"Something is wrong with the profession—has been wrong from the first. Engineering courses are not quite what they should be—not quite complete. If they were, engineers would be different. They would think in channels somewhat broader than they do; they would see with clearer and more generous vision. Engineers must think in broader channels—must see with more generous vision—if, having once moved into the forefront, as they will, they would remain there—would not go back—as the clergy has gone back, as the law has gone back, as medicine is going back. Once to the front, engineers could stay there. They could stay there if only they would profit by the mistakes of their brethren in the older professions, and study the New Management. Which means that engineers have got to forget some things and learn some other things. Forgetting, and learning, they will have attained to mastery over the world. . . . .

"The human element, after all, despite mechanical perfection, despite the laws governing the sum of two figures, is the vital element, the element that makes or breaks—the one science above all sciences deserving of consideration and study on the part of the engineering fraternity.

"Engineers as a race have not studied it. They have considered it, of course, as in the designing of apparatus;

but this consideration for the most part may be summed up and dismissed—as it is summed up and dismissed in all drawing-rooms—in a single compound word, 'fool-proof.' Making a thing fool-proof, and the engineer, as he sees it, has done his bit. In this direction a few engineers have done a great big bit—automatic machinery in some fields creates wonder and amazement in the onlooker. But these instances have been rare—few and far between—and the work of a very small group of engineering minds. And while the word 'fool-proof' itself symbolic of the mental attitude of the engineering world toward humanity at large—is a word well understood in engineering circles, yet the human element as a factor in the operating of machinery is not taken into consideration as much as it could be, should be, and will be, in time. . . .

"Out of all this emerges a broad general conviction. It is that the engineering mind, taken collectively, is a narrow mind. If it is a narrow mind—and, personally, I believe it is—it is so by reason of the specialized intensive training given engineers in preparation to pursue their profession. Of all the students in any university, 'engineers' are seen least on the campus, least in the gymnasium, least on the track and field. They haven't the time. It would be better for the profession if this were otherwise. Campus and gymnasium are places where the human side is brought out, and it is the human side that is lacking in development in the average engineer. Anything that would tend to develop this in the man would likewise tend to develop it in his profession. Recognition and knowledge of the foibles of humanity would broaden and soften."

As Francis Bacon, Lord Verulam, said in his essays, grant a false premise and a wonderful argument and new labor can be created. Charles M. Horton, the author of the above-quoted article, writes from a false assumption of the mental balance and intelligence of engineers. Dispute the premise, says Bacon, and the elaborate argument falls apart for lack of actual proof.

SHAWINIGAN WATER AND POWER CO.

The annual report of the Shawinigan Water & Power Co., Montreal, for the year 1917, says that water conditions throughout the year were above normal. The late spring, heavy rainfalls throughout the summer and general conditions throughout the watershed of the St. Maurice River resulted in a river flow considerably in excess of former years.

A continuance of this satisfactory condition is guaranteed for the coming year by the putting into operation of the La Loutre storage dam. This dam has been completed by the company for the Quebec provincial government. Although the amount of work involved was considerably in excess of that anticipated at the outset, the dam was completed some weeks ahead of the contract date, which was January 1st, 1918. The storage lake should be substantially full at the end of the flood period in June, 1918, and from that date the full benefit of the storage water will be available to the company and its allied interests.

The company also constructed a plant for the Canadian Electro Products Company, and increased the capacities of two other subsidiary companies, the Electrode Company and the Canada Carbide Company. A certain amount of new construction work was also occasioned by the development of the company's power business. The new work constructed at Shawinigan Falls by the Canadian Aloxite Company, a subsidiary of the Carborundum Co. of America, will require about 12,000 h.p. The work is now practically completed and the equipment is being installed. The plant will be in full operation at an early date.

The new business written by the company has exceeded that of the previous year, which was the record up to that time, and should increase the demand on the company's plants, says the annual report, by 35,000 h.p. The general industrial situation throughout that part of the province of Quebec served by the company, has been one of intensive operation of existing industries, says the report.

Referring to the coal shortage and its effect on some power plants, the report states that "in general it may be said, as regards hydro-electric development, that time is on its side and the future cannot fail to be advantageous to it."

PERSONALS

S. V. KENDALL, managing director of William Cowlin & Son (Canada), Limited, contractors, has moved his office to 154 Simcoe Street, Toronto.

A. M. MORTON, B.A.Sc. (University of Toronto) and lately with British Forgings, Limited, is in charge of the new chemical laboratory of the Alloy Steel Works, Limited, Toronto.

B. F. HAANEL, B.Sc., chief of the Division of Fuels and Testing, Mines Department, Ottawa, addressed the Royal Canadian Institute, Toronto, last Saturday evening on "The Fuels of Canada."

H. I. ARMSTRONG has been elected managing-director of the Alloy Steel Works Company, Toronto, a new corporation which has been formed to take over and operate the Moffatt-Irving Steel Works, Limited.

A. V. DELAPORTE, B.A.Sc., chemist in charge of the experimental station of the Provincial Board of Health of Ontario, has joined the overseas forces and is now in England qualifying as an officer in the Royal Engineers. He had been attached to the Hydrological Corps with the rank of captain and served at the Toronto Exhibition Camp last winter.

HON. W. J. HANNA, K.C., formerly Ontario provincial secretary and more recently Dominion food controller, has been elected president of the Imperial Oil Company to succeed Walter C. Teagle, president-elect of the Standard Oil Company of New Jersey. Mr. Hanna has been the legal adviser of the Imperial Oil Company since the earliest days of the company's existence and latterly has been one of its directors and vice-president, although his chief activities for several years past have been of a public nature.

OBITUARIES

Flight-Lieut. ROSS HARRISON, of Kingston, who was for some time inspector on the construction of the Canadian Northern Ontario Railway, and later employed on munitions by the Canada Locomotive Co., Kingston, was instantly killed in a flying accident at Fort Worth, Texas, on December 23rd, 1917.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Water Filtration Plant at St. Hyacinthe, P.Q.

Four Units Each of One Million Gallons Daily Capacity — Central Location of Office Facilitates Supervision and Operation of Plant—Improvements o Fire Service

By FREDERICK ELBERT FIELD, B.Sc.,

Consulting Engineer to the City of St. Hyacinthe

THE CITY of St. Hyacinthe, located about 35 miles east of Montreal, is a rapidly growing and prosperous manufacturing municipality, with a population of about 12,000. Its progressiveness in matters pertaining to the public health is indicated by the promptness with which it has proceeded with the filtration of its water supply.

Present System

The waterworks pumping station is on the bank of the Yamaska River above the centre of the city and receives its supply through a 20-inch suction pipe. The pumping equipment includes one 2-million-gallon-daily Holly steam pump, two 1¼-m.g.d. single-stage centrifugal pumps, motor-driven, and one 1¼-m.g.d. two-stage centrifugal pump, motor-driven.

The two single-stage centrifugal pumps are generally used for domestic service and deliver water at about 60 pounds pressure. The Holly pump and the two-stage centrifugal pump are reserved for fire service and deliver water at about 120 pounds pressure. The piping connections of the two single-stage pumps are so arranged as to permit of the pumps being used in series, thus delivering water for fire service at about 120 pounds pressure.

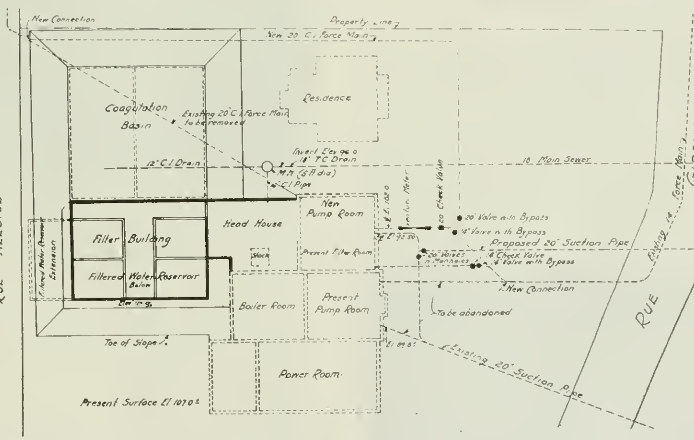


Fig. No. 1.—General Plan of St. Hyacinthe Filtration Plant

There is no reservoir or storage tank, and water service is maintained by direct pumpage.

The unsatisfactory quality of the river water for domestic use, and deficiencies in the arrangement and capacities of the pumps for prompt and ample service at time of fire, indicated the need for extensive improvements.

During the winter of 1915-16, the city received tenders for a filtration plant and accessory work upon the basis of competitive designs furnished by the tenderers. The great difference in the prices tendered for the work and some uncertainties regarding the tenders, resulted in the rejection of these tenders and the engagement of an engineer to prepare plans and specifications for the proposed work. New tenders were received on June 28th, 1916, but war and other conditions delayed the award of the contract until too late in the season to start construction work.

The contract was awarded to the Roberts Filter Mfg. Co., of Darby, Philadelphia, who sub-let the construction portion of the work to Arsenault & Plamondon, of Montreal. The cost of the work will be about $120,000. Construction was started in the spring of 1917 and the new system is now approaching completion.

General Description of New System

The filtration plant contract includes:—(1) The remodelling of the present pumping station to permit of the re-location of three of the existing pumps and the installation of new pumps and equipment.

(2) The construction of coagulation basins, filters and filtered water reservoir.

(3) The construction of filter building and head-house, the latter containing the office, laboratory and coagulation room.

The location and arrangement of the new work with respect to the existing system is shown in Fig. 1.

The "proposed 20-inch suction pipe" and the "filtered water reservoir extension," indicated in Fig. 1, are not included in the present contract.

The easterly end of the existing pumping station, which formerly contained two pressure filters, becomes the new pump room and will contain all pumping units with the exception of the Holly steam pump. Adjoining the pump room is the head-house, one door of which opens directly into the filter building. The filtered water reservoir is beneath the filters and the coagulation basins adjoin the filtered water reservoir but at a higher level.

Under the new system, the river water flows through the existing suction pipe to the pump room, where it is lifted by the raw water pumps to the easterly end of the

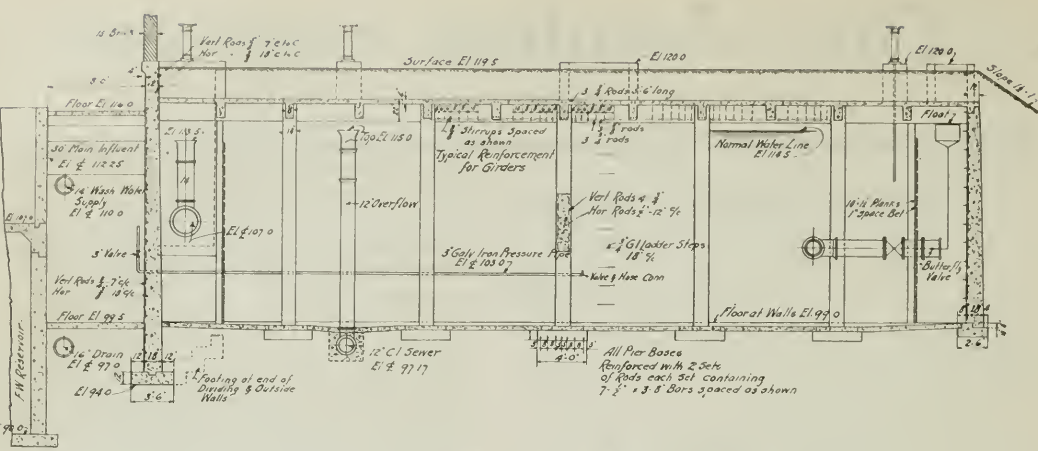


Fig. No. 2.—Longitudinal Section, Coagulation Basin

coagulation basins. It then passes through the coagulation basins to the filters, falls into the filtered water reservoir and finally flows back to the pump room, from which it is discharged either by the domestic service or the fire service pumps into the force mains of the distribution system.

Pumps and Piping Connections

The suction pipe from the river extends across the pump room below the floor of the pump pit, then rises to a higher elevation and is continued to the filtered water reservoir. Branch mains lead to the several pumping units which are located on either side of this main suction pipe.

Gate valves on the main suction pipe can be so operated as to permit of all domestic service and fire service pumps obtaining suction directly from the river in case of emergency or when the filter plant is not in operation; but when the filters are in service, all pumps except the raw water pumps will draw directly from the filtered water reservoir. The arrangement is such that there is no possibility of raw water entering the filtered water reservoir.

A Wallace & Tiernan liquid chlorine apparatus is provided and arranged to work in connection with the 20-inch Venturi meter on the discharge main from the station. The piping connections are such that the liquid chlorine is introduced into the main suction pipe before it reaches the first pump suction, whether the flow of water is from the filtered water reservoir or directly from the river. Thus all water delivered to the city will be chlorinated, even if the filter plant, on account of abnormal conditions, is out of service.

The pumping equipment under the new system includes:—

(*a*) Four 8-inch raw water, low-lift pumps (new) with a unit capacity of 1,500 Imperial gallons per minute against an overall head of 40 feet, including suction lift and friction losses. These pumps are mounted in pairs on a common cast base and direct connected to a single motor in such manner as to permit of both pumps being operated at the same time, or either pump being out of service, as may be desired. These pumps discharge through a 16-inch main into the coagulation basins.

(*b*) One 8-inch domestic service pump (new) with a capacity of 1,500 Imperial gallons per minute at 70 to 80 pounds pressure.

(*c*) Two 8-inch domestic service pumps (old) with unit capacity of 850 Imperial gallons per minute at 70 to 80 pounds pressure.

(*d*) 8-inch fire service pump (old) with capacity of 850 Imperial gallons per minute at 120 pounds pressure.

(*e*) One fire or domestic service pump (old Holly steam pump) with capacity of 1,500 Imperial gallons per minute at 120 pounds pressure.

(*f*) One 10-inch fire service booster pump (new) with capacity of 3,000 Imperial gallons per minute at 120 pounds pressure.

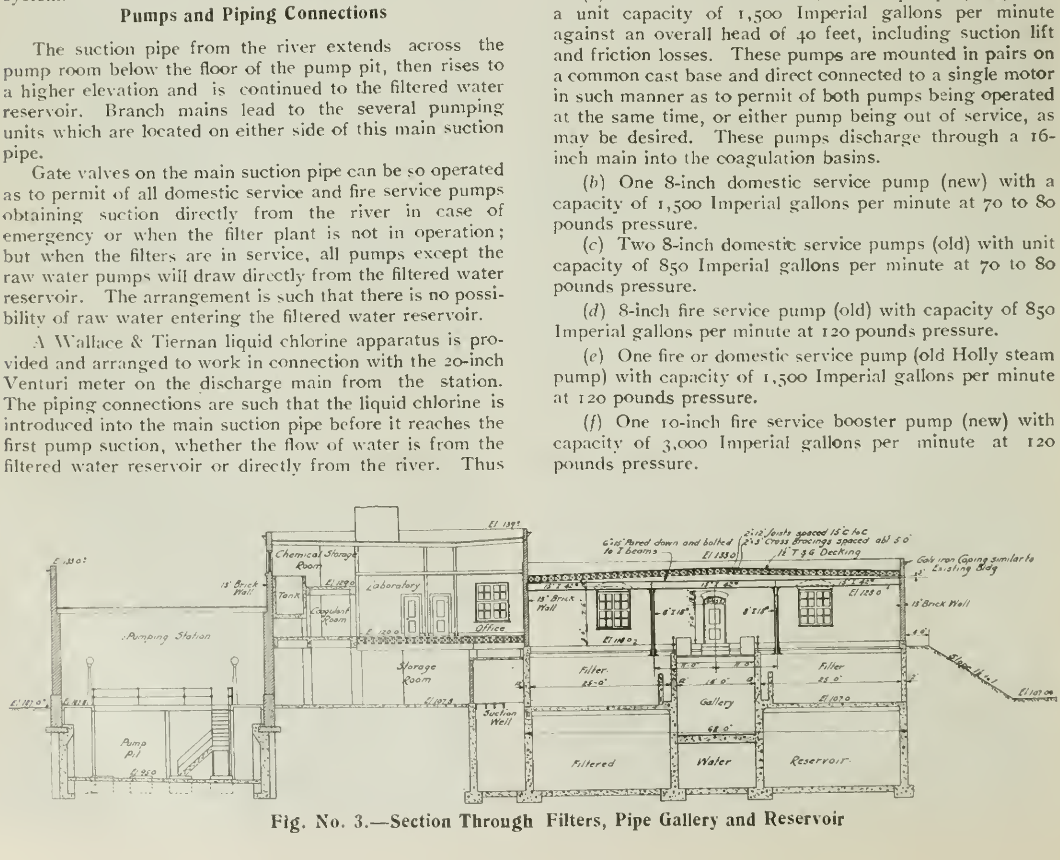


Fig. No. 3.—Section Through Filters, Pipe Gallery and Reservoir

(*g*) One 12-inch wash water pump (new) with capacity of 3,500 Imperial gallons per minute against an overall head of 40 feet, including suction lift and friction losses.

(*h*) One 2-inch sump pump (new) with capacity of 50 Imperial gallons per minute against a 10-foot head.

All pumps with the exception of the old Holly steam pump are of the centrifugal type and motor-driven. A main switch-board, wiring and appurtenance are also included in the contract.

The domestic service and fire service pumps discharge into a 20-inch cast-iron force main which supplies the distribution system.

The function of the booster pump is to by-pass the combined discharge of the domestic service pumps at time of fire and thus increase the usual service pressure of 70 pounds to the 120 pounds required for fire service. It can be promptly placed in service without requiring the shutting down of other pumps or otherwise affecting the normal operation of the station.

If desired, all discharges from the fire service pumps can be by-passed through an independent 14-inch force main and thus reach the distribution mains of the city.

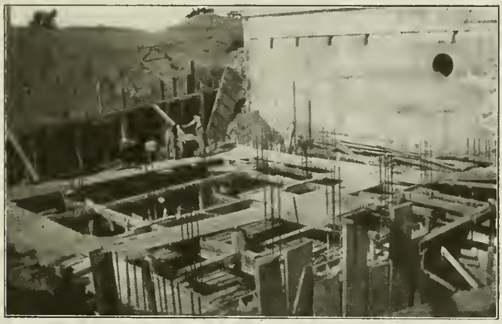


Fig. No. 4.—Pouring Wall of Coagulation Basin

Under the new conditions the capacity of the station will be:—

Domestic service, 4,500 gallons per minute = 6½ million gallons daily.

Fire service, 5,000 gallons per minute = 7¼ million gallons daily.

Coagulation Basins

The coagulation basins are entirely of reinforced concrete construction and consist of two units, each 66 feet long, 32¼ feet wide and about 18 feet deep. The roof is flat, with an earth covering 2½ feet in depth, to provide ample protection during cold weather.

Manholes in the roof, and steel ladders, permit of access to the basins. Wooden baffles extend across the full width of each basin at both the inlet and outlet ends, to provide a uniform flow of coagulated water throughout the entire cross-section of the basin.

The discharge from the raw water pumps is controlled at the inlet end of each basin by a Chapman butterfly valve, float operated, in order to maintain a normal depth of 15½ feet of water when the basin is in service.

The piping connections are so designed that one basin may be drained and cleaned while the other basin remains in service. Each basin has a capacity of 200,000 Imperial gallons. With both basins in service and delivering water at a 4-m.g.d. rate (*i.e.*, the full capacity of the plant as designed), there will obtain a subsidence period of about 2½ hours and a velocity of flow of about one-half lineal foot per minute. With the same total output and one basin out of service for cleaning, the period of subsidence is reduced to 1¼ hours and the velocity of flow increased to one lineal foot per minute. A longitudinal section of the coagulation basin is shown in Fig. 2.

Fig. No. 5.—Preparing Forms for Remainder of Wall and Top Floor of Coagulation Basin

Filters and Filtered Water Reservoir

The arrangement of this part of the work is shown in Fig. 3, which is a section through the filters, pipe gallery and reservoir. Both filters and reservoir are of reinforced concrete.

The reservoir is 66 feet wide and 39 feet long. With a maximum depth of water of 14 feet, it has a capacity of 193,000 Imperial gallons. The roof of the reservoir is the floor of the filters and pipe gallery.

There are four filters, with a unit capacity of one million gallons daily, arranged two on each side of a pipe gallery measuring 14 feet wide in the clear. The filters are 25 feet long, 19 feet wide and 9 feet deep and have a net filtering area of 432 square feet.

Fig. No. 6.—Ready to Finish Excavation for Clear Water Reservoir

The filters are equipped with a combined cast-iron strainer and air system, capable of passing wash water at the rate of 8⅓ Imperial gallons, or compressed air at the rate of about 4 cubic feet of free air per minute per square foot of sand surface.

Each filter has three cast-iron wash water gutters, with their top edges set 15 inches above the sand line.

The filtering material consists of four layers of graded gravel having a total depth of 15 inches, and 30 inches of filter sand having an effective size between .35 mm. and .55 mm.

The operating tables, filter rate controllers, loss of head gauges and depth gauges are of standard type and construction. The wash-water pump, having a capacity

Fig. No. 7.—Pouring Wall of Clear Water Reservoir

of 3,500 Imperial gallons per minute, has already been described and is included in the pump room equipment.

The blower for the air wash is located on the entrance platform alongside filter No. 1. It is of the Root type and has a capacity of 1,700 cubic feet of free air per minute against a pressure of four pounds per square inch. The blower is connected to a motor mounted on the same bed plate.

Under the present contract, only three filters are to be fully equipped for service, thus providing for a daily output of 3 million Imperial gallons. All the piping connections for filter No. 4 are provided, however, so that this filter may be completed at such future time as is deemed desirable.

There is also room on the waterworks property for two more filters, which will make the ultimate capacity of

Fig. No. 8.—Filter Building, St. Hyacinthe, P.Q.

this plant 6 million Imperial gallons per day. The pumping equipment now installed, and the capacity of the coagulation basins and piping as now designed, will need no alterations when such extension is required.

Filter Building and Head House

The filter building encloses the entire area of the filters and the operating and entrance platforms. The walls are of brick and large windows make the building light and attractive. The roof is flat, of wooden construction, and is covered with gravel and pitch laid on saturated roofing felt in accordance with the Barrett specification.

The head-house is between the filter building and the pumping station. The lower floor is to be used as a storage room. The upper floor—slightly above the level of the operating platform of the filters—contains the office, laboratory and coagulant room. The central location of the office will greatly facilitate the supervision and operation of the plant.

The coagulant room contains the alum solution tanks and the usual apparatus for the regulation and control of the coagulant. The discharge from the orifice feed tanks enters the 16-inch force main (running from the raw water pumps to the coagulation basins) at a point just outside the walls of the pump room and directly below the coagulant room.

The general arrangement and architectural features of the new work correspond in general design with the old station.

L. A. St. Marie, city engineer of St. Hyacinthe, personally supervised the work during construction.

THE ENGINEER'S PLACE IN NATIONAL SERVICE*

By Hon. Frank B. Carvell
Minister of Public Works, Ottawa

MR. PRESIDENT and gentlemen, I thank you for the warmth of your reception, but I hardly understand why you should say I am familiar with engineering matters. You know, I am a farmer. Or, perhaps some of you did not know that. Sometimes I practice law for the purpose of making a living. I have never been an engineer. But in order to show you how I appreciate the services of the engineer and to illustrate the need of working under skilled engineering advice, let me tell you a little story about my own experience. About fifteen years ago four or five other gentlemen and myself conceived the idea of developing a water power. We did not have any waterfall, and we were compelled to build a dam across a stream. We blocked out a rough sketch of how we thought it ought to be built. The dam was 40 feet high and 400 feet across the stream and 125 feet up and down the river. It was too big for cement, so we made an ordinary wooden dam. We hired a practical lumberman to build it for us the way we had worked it out, and when it was finished we thought we had accomplished wonders. But, would you believe me, when the first spring freshet came half the infernal dam went out, and the loss was a mighty serious one. That was my first experience in any engineering matter, and I paid sweetly for my experience, I assure you. I think that has been about the experience of every man who has attempted to carry on a work of that kind without the advice and service of trained engineers.

The world must be very largely rebuilt, and development must be along scientific lines which have not been followed heretofore. That brings me down to what I

*Abstracted from paper read before Ottawa Branch, Canadian Society of Civil Engineers, March 7th.

really want to impress upon the gentlemen present—not that I expect to give you a speech on this subject, for I realize that I do not know nearly as much about it as you do—and to impress upon every man and woman in this country, and that is the need of building up this and every other civilized country when this great struggle is over. There are so many things around us waiting to be done, and they can only be done on proper lines, and that means on proper engineering lines.

Without discussing the construction of more railways, I realize that the government railways must be reconstructed. They must be safe for the trains that run over them. And this work of rebuilding is going to call for engineering ability and service. But when we have considered the railway needs we have only commenced to discuss the real engineering problems which Canada has to face. I should say that the first problem we have to face is the development of our water powers. I may be considered a crank on this subject, but it seems to me that the experience of this country in the past three or four months because of the lack of coal must set every man thinking, even though he be the most ordinary layman in these matters, on the necessity of developing our water powers so as to make ourselves independent of coal as far as possible, at least for power.

When I look around the city of Ottawa, which really exists on account of the development of your water power, and realize that probably not one-quarter of the available power within twenty miles of the city is yet developed, I sometimes wonder what could be accomplished if we had sufficient money and energy to have all these water powers developed. I never drive up the Gatineau without thinking of the great water powers there that are going to waste. And up the Ottawa there is the same condition. And when you come to the St. Lawrence River you have power going to waste by the million horse-power. I am not advocating any policy—I do not think it would be wise to do so occupying the position I do—but if I might be permitted an expression of personal preference, to me there is a great deal more beauty in water power developed and working than in water power going over a rapid. I quite admit that I have not been trained along the aesthetic lines on which some of my neighbors have been led, and so may not sufficiently appreciate the beauties of nature. But I do appreciate the beauty of water going through a water-wheel.

There is another field in which, I believe, the wisdom and ability of the engineer must be used in future to a thousand-fold greater extent than in the past, and that is in the development of our highways.

I know that in many portions of Ontario this problem has been taken up in a much more scientific manner than in other parts of the Dominion, and I would couple with that the province of Quebec, because they have accomplished wonders there in the development of their highways. But, taking the Dominion of Canada as a whole, I do not think it involves any unjust reflection to say that we are somewhat behind many other portions of the world in the development of our highways. I do not have to argue before an audience of engineers the necessity of highways, not merely for pleasure travel, but for the development of the farm and for the use of the merchants and all other classes. Every man in business must utilize motive power in some form and every man must have his wares transported, whether they be manufactured articles or products of the farm. And, of course, to the farmer the highway is of as great importance as the railroad is to the business man. Sometimes I wonder why the ordinary farmer does not appreciate the value to him of a highway more clearly than he does. But, I suppose, his father got along with the old dirt road, and he says, "If it was good enough for father it is good enough for me; we managed to keep this farm without a mortgage on it with the road as it is." And yet I do find a wonderful development in the demand for better roads springing up in the country as compared with that which existed a few years ago. I can remember —and it is not very long ago—when I bought an automobile; I suppose I had twenty-five of my best friends come to me and say, "Frank, don't run that automobile around this country; you will never be elected if you do, for there is not a woman on the farm who will allow her husband to vote for you." But I want to tell you there are more than fifteen hundred of these same automobiles in my little constituency to-day, and the great majority are owned by farmers.

There is no public work or service that I know of which requires the trained engineer to a greater extent than our roads. If I had the opportunity to talk to the people all over this country, one thing which I would wish to impress upon them more than almost any other is that the services of the trained engineer should be made use of in our highway construction. I drive through the country and see men spending money in large sums on roads without even providing the most elementary need of a road,—drainage. It makes one almost sad to think of it, but if they would spend only a few dollars more in securing the advice of men who know how to build roads, they would save large sums in the long run and would have roads that would be good for years in the future.

I have very hurriedly and hastily discussed some of the things which I look upon as being among the problems that face Canada to-day and that will face Canada when the war is over. I do not think that a man should be considered as aspiring to be called a prophet because he says that the engineer must play a much greater part in the economic life of Canada in the next twenty-five years than he has played in the last twenty-five years. Already the engineer in Canada has accomplished wonders.

When we look about us and see the wonderful works which have been created by our engineers in twenty-five years, we can hardly realize the skill, the high intelligence and hard thinking required to carry them out. And when we consider also the great works that remain to be accomplished within the next twenty-five years, we realize that these works can be carried on economically and efficiently only by engaging in them the services of the trained engineer and we have some slight conception of the great field of labor which opens before the engineers of to-day. Wonderful results will follow for the country if we utilize the engineer's powers, but there will be a sad retrograde movement if those powers are not utilized.

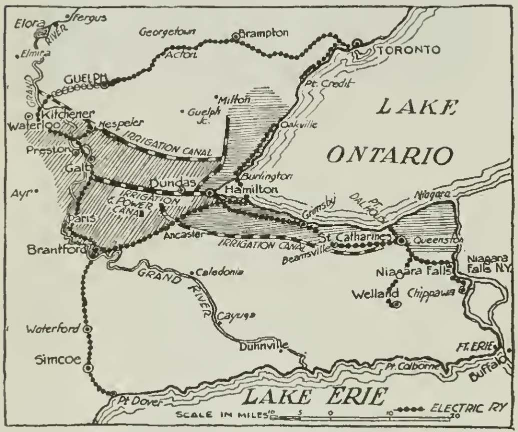
I do not want to talk shop, but so far as I am concerned, I propose doing nothing in my department except on the advice of the responsible engineers employed to give me that advice. You see, I have profited by my little experience of fifteen years ago—and I know of no way to teach a man so effectively as to make him lose twenty-five or thirty thousand dollars. I have learned that the man who attempts to construct anything without taking the advice of technical men is on a par with the lawyer who conducts his own case—and I suppose you know the rest of it, he has a fool for his client. Being both a lawyer and a Minister of Public Works, and knowing something of the consequences of not taking the best course in these matters, I have decided that, so far as I am concerned, I will rely on the advice of my technical officers on all technical questions.

GRAND RIVER FLOOD PREVENTION, POWER DEVELOPMENT AND IRRIGATION SCHEME

FOR some years the Grand River Improvement Association has been urging that conservation dams be built to create storage reservoirs on the upper waters of the Grand and of the Speed Rivers, to absorb the spring freshets and enable their subsequent and gradual release so as to avoid damage from flood. In an article in the Toronto Star Weekly, from which the following notes have been abstracted, details are given of a plan to prevent the Grand River floods and at the same time provide 15,000 h.p. and irrigate the farm lands of the Hamilton district.

The cities of Brantford, Paris, Galt, Preston, Kitchener, Waterloo, Guelph and Fergus, and a number of other Ontario municipalities, are vitally interested in obtaining freedom from the annual costly destruction by floods.

W. H. Breithaupt, C.E., of Kitchener, originator of the movement, has devoted much time to the study and



Plan of "Metropolitan District" Showing Main Proposed Irrigation Canals

furtherance of this problem. Among the reservoir sites which he suggests is a large one just below Elora, some five square miles in area.

Noulan Cauchon, consulting engineer and town planner, of Ottawa, has recently urged that the Grand River conservation be carried out not only for flood prevention, but to enable the development of power and also the irrigation of large areas of the most fertile land in Canada.

Power Project

Mr. Cauchon proposes a main canal for joint irrigation and power purposes, from a point about three miles below Galt, at the 900-foot level, through a natural pass for some three miles easterly, thence continuing across open level country to the 800-foot level on the escarpment above Dundas. This canal would be about fifteen miles in length.

At the proposed point of diversion, the Grand River drains 1,360 square miles of country, with an approximate run-off of between 14 and 18 inches (data incomplete).

It is assumed that with the building of the Elora reservoir and one or two others within easy distance, a minimum of 300 cubic feet per second could be assigned continuously for power by regulating the flow from the reservoirs.

The drop at Dundas from elevation 800 to the Dundas marsh, elevation 245, would be 555 feet within 1¼ miles. The initial power so developed would be from 15,000 horse-power up, according and as fast as more reservoirs were completed. The existing powers below Galt, in so far as affected, would be compensated by transmission from Dundas.

The Grand River would still receive its tributary waters at Paris and below; the appearance of the river would remain unimpaired by closing the dams and permitting only overflow; the domestic supply would be unimpaired.

A point in favor of this scheme is that it retains all of the conserved water over a 555-foot drop at Dundas, whereas if it be drained to run into Lake Erie, one-half immediately becomes United States perquisite and the other half, ours, will at best produce only from a 300-foot fall at Niagara.

Would Irrigate Large Area

The irrigation side of the scheme would afford enormously increased agricultural production to all the country in the vicinity of the Grand River towns and easterly to Dundas, and around Hamilton and the Niagara peninsula; the areas north, south and east of the main canal being served by lesser arteries of distribution.

A branch canal would pass easterly from above Dundas to Waterdown, and along in a northeasterly direction, to furnish water for all the hillsides of the valley below the 800-foot level, as far east as Oakville.

Another branch canal would leave the main canal in the vicinity of Capetown, crossing the neck of the Dundas valley by a viaduct or an inverted siphon, thence contouring the southern heights, passing along back of the city of Hamilton on the highland above the escarpment, and easterly towards St. Catharines.

It is from this latter ditch that the fruit country along the lake shore would be supplied with water for domestic and irrigation purposes.

It is held that irrigation would enable intensive cultivation of much of the land now farmed in the ordinary way, and so accomplish denser population on "small holdings."

This further opens a possibility of soldier settlement, with all the amenities of civilized life, as against the hardships of pioneering on bush farms in the wilderness.

It is also suggested that Hamilton could obtain a gravity water supply from reservoirs on the heights on both sides of the valley, and so dispense with pumping and its capitalized maintenance.

Effort on behalf of the towns and municipalities affected towards obtaining government action, is in the hands of the Galt Board of Trade, following a meeting of representatives there on the 7th of February.

The map of "Metropolitan District" published herewith shows main joint irrigation and power canal for diversion of Grand River water. The power house would be at Dundas; the two principal branch irrigation ditches are shown north and south of Hamilton. The irrigable area to be initially served is shown by horizontal lining.

At the annual meeting of the Canadian Mining Institute, held last week in Montreal, the following officers were elected for the ensuing year: President, D. B. Dowling, of the Geological Survey, Ottawa; vice-presidents, H. E. T. Haultain, of Toronto, and John A. Dresser, of Montreal. As the election of Mr. Dowling left a vacancy among the vice-presidents, P. E. S. Whiteside, of Coleman, Alta., was unanimously elected as third vice-president.

THE OPERATION OF SMALL SEWAGE DISPOSAL PLANTS*

By George W. Fuller
Consulting Engineer, New York City.

SUCCESSFUL accomplishments by sewage disposal plants are fundamentally dependent upon plants being operated with reasonable intelligence. No matter how well a plant may be designed and built, it is quite possible for the results to go wrong through faulty operation. On the other hand, poor or indifferently designed and constructed plants may be operated with such skill as to yield quite satisfactory results. What ought to be provided, of course, is both good construction and good operation as in this way alone can satisfactory results be secured with the best return on the funds expended and with the least likelihood of nuisance or unsatisfactory hygienic conditions.

"Small plants" is a relative expression and I shall take it to mean a sewage disposal plant ol such size that the superintendent or man in immediate local charge is obliged to attend to all operations other than those which can be performed by the better class of common laborers. This definition probably classifies all the sewage disposal plants in New Jersey, with perhaps one or two exceptions, as "small plants." The man in charge is called upon to make such laboratory tests and attend to such mechanical appliances as are necessary, with but little or no technical aid after the schedule of operations becomes once established.

Such a plant operator would undoubtedly have different duties to perform at plants of different types and under different local conditions. But his success depends largely upon the keen interest which he takes in studying the individuality of his local conditions, and the ingenuity which he exercises in applying a fair working knowledge of the general principles of sewage disposal to the problem in hand.

I desire at the outset to point to the importance of each plant operator keeping a daily record of the more important items connected with the operation of his plant. Ordinarily, these include the volume of sewage treated, stability of the effluent by the methylene blue test, volume of solids in the influent and effluent, portions of the plant in service, withdrawals of sludge from any portion of the plant, condition of filters, quantity of chlorine applied if any, and such other tests as will indicate to him at a later date what the plant performance was at any given time. Notes should be made as to any abnormal features connected with the operation of the plant, such as the appearance of odors, flies, filter clogging, and other features whereon there are varying experiences from time to time.

Each disposal plant has an individuality of its own perhaps fully as characteristic as is the case of the individual person. It is usually very helpful for the plant operator to study the behavior of his plant at different seasons of the year and keep a diary in which to record his observations on various special points. Factors are bound to arise upon which full evidence cannot be obtained until weeks and months go by and in some instances results of operation depend upon the season so that a year or two may be required in order to fully gather all evidence upon the best method of operation as regards some procedure. With biological processes the effect of the seasons may be conspicuous and it is difficult for a plant operator to carry clearly in mind information which will allow him to compare with moderate accuracy the facts observed at one season with those encountered during the same season of following years. For this reason it is of importance for the plant operator not only to record on his daily operating sheets the more ordinary points of useful information, but to keep a diary which will aid him in comparing the significance of various special points as they may arise year by year.

Sewage plant operations admittedly involve the "cut-and-try" phase of passing from the unknown to the known phases of any particular plant. Accordingly, it is desirable to try, where practicable, different remedial measures of an operating nature and to determine in this way the procedures most suitable for solving local problems. Correspondingly, the plant operator proceeds with regard to programs for plant betterments and extensions if he faces his full duty in endeavoring to ascertain how he can advise a municipality to proceed in order to get the best return for a given expenditure.

Imhoff Tanks

There are a good many sewage disposal plants which contain arrangements for the removal of settling solids before the sewage is applied to filters or large bodies of water. Imhoff tanks during the past six or eight years came rapidly to the front and for a time displaced almost completely the earlier custom of building single-story septic tanks. Under some local conditions Imhoff tanks have shown abnormalities, as has been true of all devices dealing with sewage solids.

Small plants, as distinguished from large plants, generally receive sewage which has its suspended matter in a coarser condition due to less opportunity of comminution in its flow to the plant through a smaller and shorter system of collecting sewers. Frequently the velocities of flow are low and the operator of an Imhoff tank for a small city usually has to contend with far more scum than is found at a plant for a large city. He is spared the difficulties of grit chambers for the removal of mineral matter washed from the streets at times of storms and ordinarily he has a fresher sewage than found at the larger plant. As a result of the absence of comminution along the collecting and outfall sewers, however, he finds that toilet paper and fecal matters not only are not broken up, but in some places they are mixed with kitchen wastes consisting of debris which ought to go to the garbage can, as well as grease which tends to stick together the coarse particles.

When coarse matters reach the Imhoff tank they carry responsibilities which the operator quickly realizes, such, for instance, as the importance of seeing that deposits do not occur in the inlet channel nor upon the sides and sloping bottoms of the flowing-through or upper compartment of the tank. These should be removed with convenient tools and made to pass a couple of times a day or oftener through the slot into the sludge-digestion chamber. If they are allowed to remain they will promote putrefactive changes not only within themselves, but in some measure will affect the composition of the sewage, which flows over them.

In the sludge-digestion chambers it requires some time for the solid matters to become converted through biochemical agencies to an inodorous sludge which may be withdrawn to sludge-drying beds without the likelihood of nuisance as to odor. This sludge digestion is not adequately accomplished until after the plant has passed through what is termed a "ripening process." The termination of this period seems to be found when bio-

*Abstracted from paper read, at meeting of New Jersey Sewage Works Association at Trenton, N.J., Feb. 15, 1918.

chemical conditions produce liquid ferments or enzymes which decompose the unstable portions of the organic matter to a stable humus residue. No doubt substantial quantities of unstable organic matter are decomposed during the ripening process by direct bacterial development. And the growth of numerous kinds of bacteria causes gasification to result from the decomposition of the organic contents of the digestion chamber, particularly the soluble portions. The bacteria doubtless attack the solid matters to some extent, but it is my idea that it is the duly established liquid ferments, or excretions from the bacteria, which decompose the solid portions of the sludge and without which action sludge digestion or septicization is not working on a normal basis.

It is frequently said that the right kinds of bacteria will sooner or later become established in the sludge-digestion chamber of an Imhoff tank. This seems to be a loose statement, and is intended to mean that sooner or later the right kinds of excretions or ferments from the bacterial growths will develop in effective quantities, They may disappear, however, and it may be necessary for a tank to pass through two or more ripening stages without any warning as to when or how this situation arises. With suitable ferments there is no measurable odor from the digested sludge if the chamber is large enough to keep the sewage solids there for a sufficient time to derive full benefit of the process. Decomposition products will not normally give serious trouble if gases are released at a fairly uniform rate and the odoriferous compounds afforded an adequate opportunity for absorption by the overlying liquid.

The proposition in hand, therefore, is that of seeing how best and most quickly to get the proper kinds of liquid ferments in the sludge-digestion chamber established and how most certainly to guard against the cessation of their adequate performance. In other words, the odors coming from sludge digestion arise as the result of only partial decomposition and seemingly by direct bacterial action. Odors are incident in part to incompletely decomposed solids and in part to unabsorbed intermediate products of decomposition. They become negligible when the ferments or enzymes are working adequately and regularly.

Sludge digestion and practical absence of odor are the normal result through proper enzyme action, whereas the ripening process and the re-establishment of an adequate digestion through enzymes is the abnormal situation. What to do to minimize and remedy the abnormal phase is an important matter for the plant operator.

Vegetable wastes which should have been sent to the garbage can and kitchen grease tend to bind together the coarse solid matters coming from water closets and form a mass through which it is difficult for the gases to force an adequate channel for their exit through the scum in the gas vents. The effect seems to become cumulative. In some places scum and gas will build up in quantities so that in spite of efforts to break up the scum the gas will find its exit through the trapped slot. In other cases the gases will build up sufficient pressure to force an exit through the scum in the gas vent and at times to release decomposition products of a nature and in quantities such as to produce offensive odors.

Gas-lifted sludge, or scum, does not seem to decompose in the gas vents in a very satisfactory manner. In fact, the process seems to be retarded so that for months at a time decomposing solids in large quantities are carried in the gas vents and ultimately they require removal and burial or other treatment to guard against nuisance from odor.

Retarded decomposition of this scum seems to be due in part to its relative solid nature with inadequate water for washing away or at least mixing and diluting the products of decomposition due to growths of bacteria which seem incapable of producing the right kinds of ferments or enzymes. This was the situation found in the sludge trenches at Kings Park, N.Y., and other places where sludge remained for many months in only a partially decomposed condition.

The plants which receive only a relatively small amount of sewage in the earlier months of their operation behave far better than do tanks which have a relatively high load factor at the outset. This goes to confirm the general belief that sludge-digestion chambers should be made materially larger than was believed to be necessary in earlier years. This also seems to be the more recent view of Dr. Imhoff who, in his article in Engineering News, January 13th, 1916, prescribes that for towns of 5,000 population or less, having separate sewers, there should be sludge-digestion capacity of at least 2.4 cubic feet per person. This is probably none too large and even with digestion chambers of this size it is necessary to realize that most of the solid matters may be stored above rather than below the elevation of the slots.

When an Imhoff tank gets into such a condition either through the initial ripening period or through abnormal developments subsequently it is not a small task to correct the situation quickly or completely. The German custom of removing the floating material and burying it as quickly as this can be done without offense has much to commend it and may be absolutely necessary as a final result.

Sludge beds should be much larger than originally prescribed by Dr. Imhoff, due to the distribution and intensity of rainfall in this country. For instance, from June 1st to October 31st, 1917, rainfalls of 0.50 inch or more occurred at Trenton as follows: June 7th, 1.06 inches; June 14th, 1.02 inches; July 3rd, 1.11 inches; July 10th, 0.67 inch; July 12th, 0.52 inch; July 26th, 0.60 inch; August 16th, 0.94 inch; September 1st, 1.69 inches; September 8th, 1.33 inches; October 12th, 0.60 inch; October 24th, 1.16 inches; October 27th, 0.58 inch; October 30th, 1.32 inches.

Summary of Operating Experiences With Imhoff Tanks

1. Small plants of the Imhoff tank type, receiving the flow of separate sewers, are frequently more difficult to operate than larger ones receiving the flow of combined sewers, because the relatively large size of the suspended particles reaching the digestion chamber respond for long periods at a time to flotation rather than sedimentation.

2. Careful attention to the prevention or frequent removal of stranded solids in the collecting sewers, inlet channels of the tanks and on the bottom and sides of the upper or sedimentation compartment; to the uniform distribution of solids in the several sections of the tanks; to the frequent removal of grease and scum from the surface of the sedimentation compartment, is helpful and important. But it will not necessarily eliminate abnormally long periods for the "ripening process," following which well-digested sludge is obtained without objectionable odors.

3. Normal digestion of sludge to an inodorous humus mass, with a fairly uniform liberation of the resulting gases caused by the inevitable splitting apart of carbon, hydrogen, nitrogen and sulphur atoms contained in the complex molecules of suspended organic substances, is seemingly effected by enzymes or liquid ferments excreted by certain kinds of bacteria.

4. When tanks are new, and when for any unforeseen reason old tanks lose their efficient digestive functions, ordinary bacterial decomposition predominates over enzyme digestion; with attending possibilities as to odor complications from incompletely digested sludge, or from the release of intermediate decomposition products, particularly those of a sulphurous nature, or from both. Tanks in this condition are said to be undergoing the "ripening process," which fortunately does not seem to be necessary as a rule other than with new tanks, although there have been some exceptions to this general experience.

5. There is no way of telling in advance how long a period of ripening may be necessary for a given tank, as different results come in different units of the same plant. Some kinds of bacteria grow prolifically and preclude the development of suitable enzyme-producing bacteria as a result of "bacterial antagonism" caused by the excretion of waste products. This may be as capricious a matter as the occurrence of weeds in a field or of algae in an unpolluted lake. "Seeding" a tank with ripened sludge from another tank has not proved to be as reliably helpful as was expected.

6. Objectionable odors may arise in varying degree, depending upon local factors, but largely upon the lack of opportunities for absorption of odoriferous compounds by surrounding water and upon accumulations of gas which may be released intermittently in masses or "whiffs," so to speak, following barometric changes and interruptions in free venting.

7. The secret of success in operating Imhoff tanks is to retain in them relatively small quantities of decomposing solids and to do all that is practicable to secure a proper balance between enzyme liquefaction and bacterial decomposition with a predominance, of course, of the former. This explains why tanks receiving only relatively small quantities of sewage when new do so well in digesting sludge. It raises the issue of sludge storage capacities.

8. Quiescent masses of sewage solids, either scum or bottom sludge, are scarcely capable of satisfactory decomposition as antagonistic products of bacterial life seem to have a decidedly retarding effect.

9. Lime will lessen excessive acid formation in sludge, but it will scarcely cause the establishment of the right kinds of bacteria for enzyme production. In fact, it may result in increasing abnormalities.

10. Agitation through pressure water jets or paddling may be of aid and in Europe mechanical stirring devices have been proposed. The benefit of stirring and mixing seems to lessen with increasing volumes of sewage solids in a tank, due to a loss of efficiency of the stirring arrangements. This step, if carried too far, may also remove entrained gas to such an extent that non-gaseous, sticky, foul-smelling sludge is obtained under circumstances requiring its removal and burial or treatment with a deodorant.

11. Acid foaming at gas vents sometimes becomes very bothersome where the gas vents contain large quantities of floating scum undergoing bacterial decomposition in the absence of adequate enzyme digestion.

12. Slot trapping by gas and gas-lifted solids, which fill the space above the slots, frequently accompanies foaming and may carry decomposing solids into the settling compartment from the sludge chamber below as well as by overflowing from the top of the gas vents.

13. Overflowing from foaming cannot be stopped in some tanks even if the gas vents extended 5 or 10 or more feet above the flow line. High free board, hosing with pressure water, stirring and liming, all tend to help, but collectively may not be a prompt cure. Aggravated cases are not cured by putting a tank out of service for months. In some tanks sludge removal from the bottom affords a remedy, but this is not available for tanks containing most of the solid matter in a floating condition. The sure remedy then is to remove the great bulk of floating solids from the gas vents until only small quantities remain. Obviously such removal must be done in a way to minimize offense.

14. Scum storage for floating solids above the elevation of the slot should be provided for much more liberally than hitherto for small plants, expected to receive during the first year of their operation a substantial proportion of their normal daily quantity of sewage.

15. Scum removal may be necessary in some plants even where there is fairly liberal allowance for scum storage. It depends partly on intensity of gasification, partly on the adhesiveness of the scum (gas-retaining capacity) and partly on the success attending efforts to make portions of the sludge remain in the lower part of the digestion chamber. In aggravated cases scum removal is imperative, but it should be carried out with caution.

16. Scum prevention comes about in some degree through comminution incident to pumping and may be further aided through the use of screens. Sometimes screening is provided in front of pumps. At Rochester, N.Y., the flow of a gravity outfall sewer now passes through a fine screen on its way to Imhoff tanks. Similar provision has been recommended at Plainfield, N.J. Such a step adds materially to the cost of sewage treatment, but evidence at Reading, Philadelphia and Chicago shows that it reduces scum formation to a substantial degree. Its advisability for a given project depends upon whether the need is commensurate with the cost.

17. Normal Imhoff sludge is dark-colored, practically inodorous and shows a curdled appearance when it flows in a thin layer down the side of a container. Much difficulty with odor has followed the withdrawal of undigested sludge to a drying bed and an operator should carefully note the condition of the sludge before and during its removal. But difficulty has also resulted from retaining sludge for a year or more in a tank under conditions where suitable enzyme digestion does not prevail. Such sticky gray or yellowish sludge may be foul-smelling, but it is wisest in some cases to remove it, with greatest care taken to prevent nuisance from odors. Complete digestion is not always attainable.

18. Sludge storage capacities are provided for more liberally than formerly and with good reason. It is not unusual to find extremely thin or dilute sludge in a digestion chamber and this high-water content is quite a factor in causing a demand for larger sludge chambers. Another item is the relatively long period of cold weather during which little or no sludge can be removed. This applies particularly to northern plants put in service during the late summer or fall.

19. Sludge beds should be at least double the areas recommended by Dr. Imhoff, due to the frequency and intensity of rainfall in our northern States,—unless covers of the hot-house type should be provided.

20. It is well to empty idle tanks and conduits; otherwise offensive odors may ensue.

Zero weather has recently put some filters severely to test, while others have not been seriously bothered.

PRELIMINARY WORK ON PROVINCIAL HIGHWAYS*

By Geo. Hogarth, O.L.S., A.M.Can.Soc.C.E
Engineer of Highways, Ontario.

THE Provincial Highways Act was passed at the 1916 session of the Legislature and was to take effect on a day proclaimed by the Lieutenant-Governor of Ontario. On April 10th, 1917, the Act was proclaimed and on August 21st, 1917, a provincial highway was assumed through the counties of Ontario and Durham. The road thus assumed is known as the Kingston Road and passes through the southerly portions of the townships of Pickering, Whitby, Whitby East, Darlington, Clarke and Hope. No road was assumed in the towns of Whitby, Oshawa, Bowmanville or the village of Newcastle. All structures on the assumed road were taken over and a careful examination made to determine what repairs, if any, were required to make the structure safe for public travel.

When the road was assumed, certain standards were established for width of roadway and cross-sections of ditches. The width of right-of-way in different parts of the road as fenced varied from about 40 feet to nearly 70 feet, and while a definite width of roadway and ditches

Thorough Ditching is Important

was decided upon, the question of total width of road allowance was left open for further consideration. Two designs for a road allowance have since been drawn up, one for an allowance 66 feet in width, and a second for an allowance 86 feet in width. It was found that the 86-foot width was required to provide for everything essential to public highway; that is, the surface of the roadway, the ditches, telephone lines, power lines and a bordering of trees. The width of roadway adopted was 28 feet and provision is made for widening to 30 feet at some future date. In addition to the establishing of roadway standards a pamphlet of regulations was issued governing the construction and maintenance of telephone and power lines on such highways.

When taking over the road it was considered that a comprehensive system of maintenance of the highway would be inaugurated. This has been carried out, and last fall every preparation was made by proper ditching, drainage and gravelling to place the road in such a condition that next spring one man will be able to keep a section of some length in a good condition for travel. To round out a good maintenance system requires that proper attention be given to the safety of bridges and culverts, and in some cases this involves the rebuilding of structures which are beyond repair. The maintenance system has been gauged to provide for the traffic passing over the road and a surface is being developed so that the ordinary operations of grading and split-log dragging will keep the road in good condition. Several sections of the Provincial Highway had been gravelled from time to time by the townships before the province took over the road. These sections while under township management had only statute labor applied to them and were in fairly passable condition, thus proving that the gravel road may give satisfaction until such time as increasing traffic demands a stronger surface.

With this precedent as a guide, it was decided to gravel the road over those sections which were most in need of such material. This condition was met with over the greater length of the road and a gang was put on in each township to haul and place gravel. The roughest sections were first gravelled and as work progressed and as more towns were available it was possible to gravel or patch a fair percentage of the length of the road.

Before work was commenced there were two sections of the road which were so rough that it was impossible to drive at a greater speed than 4 or 5 miles per hour. Two or three weeks after work was commenced these sections were comfortable to ride over and several weeks later when traffic had consolidated the gravel the entire road could be travelled from end to end in comfort and at a fair rate of speed.

While gravelling was begun as soon as the road was assumed, the grading and rounding-up of the surface was not lost sight of and a light grader was purchased. This machine was used to cut off the shoulder and cast it out towards the ditch, thus giving a rounded-up section which shed water. A heavy grader, built to be drawn by a 20-horse-power tractor was later bought, as better results were more rapidly obtained on some sections with the grader than by gravelling. The heavy grader, when drawn by a tractor, proved to be a time-saving device, and being powerful and well-built no time was lost from breakages and repairs.

Several sections of the road were early marked out for improvement of the drainage and ditching. These sections were on long hills in cutting where the original roadway had not been excavated wide enough. Little or no provision for side ditches had been made and the water during rainstorms followed down the centre of the road. Drag scrapers were employed to move a large quantity of material and in this manner a wide cross-section was made with side ditches about 2½ feet deep. On one hill where the haul was quite a distance, the earth was moved with carts and used to widen out a narrow fill in the valley. The completion of this work made a marked improvement in the roadway and completely eliminated wet spots and springs which formerly occupied the centre of the highway.

The ditches during this winter also gave evidence of being able to intercept water flowing off the hills and so prevent it flowing onto the road and creating bad ice conditions. The evidence to-day is that the road in a cutting having deep side ditches is dry and the road with inadequate ditches is covered with ice. One hill which was widened and improved with deep ditches had always been soft and troublesome to maintain. When opening the side

*Paper read before the Fourth Annual Conference on Road Construction.

ditches a spring was discovered half-way up the hill in the north ditch and a drain tile emptied under the road at the south side. Water flowed continuously in these side ditches after they were opened and the action of this section of road will be carefully watched during the thaw this spring.

The examination of the bridges and culverts showed that some attention was required immediately. Water flowing down the road and through the floor of the bridge had undermined a large abutment to a considerable extent. This excavation was filled with field stone and steps taken to divert the water so as to prevent further damage. A number of timber culverts were in an advanced state of decay, the wood being eaten up with dry rot. Concrete culverts replaced these structures.

One point with reference to all culverts is that they are built the full width of the roadway and not less than 30 feet is allowed between the inside faces of the endwalls. This gives a roadway unobstructed by handrails and guardrails and removes to a great extent the danger of accidentally running over the end of a short culvert. The roadway is graded over all culverts and at least six inches of gravel placed on top of the concrete slab.

Several steel bridges are on the highway. They are all of light construction and not suitable to the heavy loads passing over the highway to-day. It is expected that one of these bridges will this summer be replaced by a substantial concrete culvert of ample opening, and in that manner a narrow roadway and dangerous turn will be eliminated. All new bridges and culverts are being built to carry class "C" loading, the concentrated load of which is a 20-ton road roller. The clear width of roadway on all through structures will be 20 feet and sidewalks wherever provided will be 6 feet in clear width.

In this connection it might be well to state that automobile moving vans and heavy motor trucks from Toronto and Hamilton are continuously passing over the highway. Some of these trucks are more than 9 feet wide and when loaded weigh up to 15 tons. This traffic has been forced onto the highway and is rapidly increasing. A motor truck will take a load of goods direct from a factory or house in Hamilton or Toronto and deliver them at their destination in Whitby, Oshawa or Bowmanville in a few

Before Treatment. Note Dangerous Turn

hours. This is almost as quick as the material could be loaded onto a freight car and two handlings with consequent damage are saved if the goods are taken by motor. The motor trucks on the highway are rapidly increasing, and this business should develop wonderfully during the coming summer.

In several places the view in travelling along the highway was very much obstructed due to trees and sharp turns hidden by bushes and other obstructions. One turn which was nearly a right angle was so obstructed that no view of an approaching vehicle could be obtained until the cars approached within a very short distance of each other, and the turn, combined with the blinded view, made the corner particularly dangerous. A small piece of property was obtained to round off the corner, a number of telephone poles, stub poles, guard rails, fences and

After Corner Had Been Rounded

rural delivery boxes were moved away and the entire corner was opened up so that good vision is obtained, and the danger of accident is avoided.

Two steam tractors were purchased for hauling the graders and handling trains of three gravel wagons, each wagon having a capacity of $3\frac{1}{2}$ cubic yards. Steam power was selected because of simplicity, ease of repairs and the possibility of obtaining local help to operate steam engines as against experienced mechanics being required to operate any other kind of power. These engines operated continuously for about three months, after which one was used to heat gravel for a culvert that was started late in the fall. No difficulty was experienced in keeping these machines in operating condition and they gave good satisfaction. In order to keep the boilers in proper condition they were washed out at the end of each week.

A system of maintenance is being considered for the entire road for the coming summer. The road will be divided into convenient sections and a local man employed to look after each section. The sectionman will have a split-log drag and will be expected to keep the road and ditches open and apply gravel from convenient pits as may be required.

IRON AND STEEL ORGANIZATION

An iron and steel section of the Canadian Mining Institute is being organized. Some of the members favor a separate Steel and Iron Association, but it has been agreed to act as a section of the Mining Institute for the time being, at least. The following have been requested to act as members of an organizing committee:—

Robert Hobson, Thos. Cantley, Mark Workman, W. C. Franz, Alfred Stansfield, W. A. Jannsen, H. M. Jacquays, G. A. Irwin, C. F. Bristol, Esmond Peck, G. H. Duggan, P. L. Miller, J. J. Hartley, D. H. McDougall, F. H. Crockard, Geo. W. Watts, Wm. Inglis, J. G. Morrow, F. A. Sherman, W. M. Currie, David Carnegie, David Kyle, T. R. Deacon, Fleet Robertson, and Geo. C. Mackenzie.

EARTH SLIDES; THEIR CAUSE AND CURE*

WATER lubricates and lessens friction. Water accumulates a head, and forces itself into and through otherwise impermeable material, thus extending the lubrication; but the greatest effect of water is from its pressure. It acts like millions of jack-screws, under and back of the slide, to produce motion. The film of water back of and under the slide has only to be thick enough to be continuous in order to transmit the pressure of its whole head in this manner.

We have articles on the pressure of water under dams. A slide is a dam, in all essential features, until motion begins. Then, fortunately, the continuity of the water film is broken. At the instant the continuity is sufficiently broken, motion ceases. Then, if conditions are right, the inflow of water increases the continuity of the film, flows into the cracks, and motion again begins.

A slide is frequently a number of dams, according to different planes of motion, any one of which may move. It matters not how saturated is the mass above the bottom of the slide, the analysis of bottom pressures and effects is not changed thereby. Although slides of some extent offer at first varying evidence, crumpling at the toe, upheaval in places, subsidence at the head, and lateral motion in varying degrees, they can all be traced to one phenomenon by proper analysis. There is frequently a swampy place at the head, sometimes attaining the dignity of a lake. There are usually springs at the toe, frequently also along its trace on the surface. These may develop by erosion into gulches which hide the cracks, the crumpling, and other evidences of motion.

There is no need to enlarge on the cause of slides. Every fact in evidence can be traced directly to water, principally to its pressure.

Sometimes, the surface can be drained sufficiently to effect a cure. Surface drainage will always help; but surface drainage is often difficult, especially after motion has developed a cracked wart-like surface, as this tends to hold rainfall and guide it to the surface of motion, or several surfaces of motion.

Sub-drainage, which will kill the water pressure, is infallible. There never has been a slide that could not be cured in this way. There are cases where the expense is not warranted. There are cases where the whole slide can be sluiced away. There are also cases where the motion is so slow, or its effect so small, that the removal of the material as it comes, or not removing it at all, is the best answer. Incidentally, removal is drainage.

Subsidence at the head of the slide tends to the formation of swamps and lakes, which, in turn, supply the water to fill the cracks, to form the pressure, to produce motion, to make more subsidence, and so on in a never-ending cycle. The interruption of this cycle is most certainly accomplished by killing the head of water acting on the surface of motion. Draining the swamps and lakes will help. At Panama one enthusiast proposed concreting the whole surface of the slide to prevent the ingress of water. This might do, if there were not probably some subterranean supply of water, possibly with a great head, that would not keep out. Such construction might be an actual hindrance, instead of a help, and might serve to hold the water and increase, instead of decrease, the head.

In some cases increasing the resistance to motion has been tried, by masonry and wooden bulkheads. These have been effective where it only needed another "straw," but have generally been disastrous. Drainage by perforating the bulkhead is taught as a rudiment in retaining walls.

Far apart as they may seem, there is much similarity in slides, retaining walls, and dams. The analysis is nearly identical, gravity, friction, and hydrostatic pressure. Sub-drainage will cure the slide, is necessary to the stability of the wall, and increases the safety of the dam.

All study is for the purpose of developing or properly applying principles. The result is education. The principle of slides is: Cause, water; Cure, drainage. There are no exceptions, though, at first sight, some may appear.

*From the January, 1918, Proceedings of the American Society of Civil Engineers. Discussion by Mr. George L. Dillman, San Francisco, Cal., of paper by D. D. Clarke, "A Phenomenal Land Slide."

SYNOPSIS OF MINERAL PRODUCTION, 1917

According to the preliminary report on the mineral production of Canada, the total value of the metal and mineral production in 1917 was $192,982,837. Compared with a production in 1916 valued at $177,201,534, an increase of $15,781,303, or 8.9 per cent., is shown, while compared with a production in 1915 valued at $137,109,171 there is shown an increase of $55,873,666, or 40.8 per cent. An examination of the record shows that the quantities of many important products were considerably less in 1917 than in 1916, and over two-thirds of the increase in value is to be attributed to coal, gypsum and cement, in which the quantities marketed were less than in the previous year. Gold, silver, copper and lead show a smaller output. As against these decreases there has been an important increase in the production of zinc, cobalt, molybdenite and nickel.

In quantity, the increase in production of molybdenite is over 73 per cent., that of zinc over 33 per cent., of pyrites 30 per cent., and of quartz 50 per cent., while the decrease in pig iron from Canadian ore is 60 per cent. of the 1916 production.

A striking increase in the production of Bessemer steel occurred. In 1916, the production was 31,388 tons; in 1917, 951,656 tons—an increase of over 300 per cent.

The Ontario production of petroleum in 1917 was, according to the records of the Department of Trade and Commerce at Ottawa, 202,991 barrels. The production in barrels of the various fields, as furnished by the supervisor of petroleum bounties at Petrolia, was as follows, in barrels: Petrolia and Enniskillen, 74,267; Oil Springs, 46,902; Sarnia township, 4,493; Moore township, 6,282; Plympton township, 579; or a total for Lambton of 132,523 barrels; Bothwell, 29,682; Tilbury, 10,041; Dutton, 2,941; Onondaga, 382; Moza township, 20,998; and Thamesville, 6,420. The bounty supervisor states that "A new, extensive oil field at North Glencoe in the township of Moza in the county of Middlesex has created a great deal of interest among oil producers and has already produced about 21,000 barrels. This new production has offset a continued falling-off in the production from the older fields."

From the point of view of value of mineral production, Ontario takes the lead with over 46 per cent. of the total, an increase of over 10 per cent. above 1916. British Columbia is second with over 18 per cent., a decrease of 9 per cent., and Nova Scotia third with slightly over 13 per cent. of the total production, an increase of about 26 per cent. above the preceding year.

Letters to the Editor

Possible Engineering Legislature Enactments

Sir,—In his article dated January 29th, 1918, printed in *The Canadian Engineer* of February 14th, Mr. Peters has shown that he has at heart the desire to see our beloved profession occupy its right place; that is, the first amongst the learned professions. Mr. Peters, in starting a discussion on such an important subject, deserves the thanks and support of all true engineers.

Referring to the third paragraph of Mr. Peters' article, I may say that the time was so short to have a long article printed before the general meeting of January last, that only parts referring to legislative enactments were given and certainly some explanation is necessary as to the motives for bringing in the part of the resolution passed by the Manitoba Branch referring to the organization of the different classes of the engineering profession.

Such an organization would enable us, engineers, to give a better service to the public and derive therefrom a benefit both collective and individual.

Let us, therefore, organize, for in organization is the secret of strength, the basis of influence and the opportunity for power. Organization nearly made Germany mistress of the world, and do not forget that disorganization has delivered Russia bound hand and foot to our common enemy. Remember that it is only with organization and still more organization carried to the extreme limit, that we shall be able to crush this extremely powerful, devilish organization.

You may say that engineers are merely human beings. It is all very nice that they should look after the welfare of the public, but in return would it not be just that the public should look after the welfare of a class of men who do so much pioneer work for them?

What are the actual conditions of the average engineer to-day? He has to have a thorough education, necessitating a long stay in college, university or technical school until he has attained his majority at least; after that he must have a long training to become efficient, and it is only after he has reached mature manhood, say, from 40 to 45 years of age, that he is able to live on the same level as members of the other professions. Until then, he is not more highly considered, nay, he is often less highly considered than an ordinary mechanic or skilled laborer. The mechanic or skilled laborer has not to worry about his personal appearance while at work; old and dirty clothes suffice for his position; not so with the professional man, who is expected to keep up a certain style and fulfil certain social duties, often of an exacting nature. All this constitutes a very great difference in the cost of living, particularly in these days when prices have increased so enormously and monetary calls have become so numerous.

Looking at this situation from another angle, the average engineer to-day is paid not more, but rather less, than he used to be, say, forty years ago. I refer to the time of the Canadian Pacific Railway construction. In some cases the salaries paid them were higher than now and certainly the capacity of the engineer of those days was not so severely taxed as it is to-day. On the other hand, the skilled laborer and mechanic through their organization have been able to command fancy wages—wages which many competent engineers of good standing would be quite satisfied with as salaries.

But is not this state of affairs in a great measure our own fault? Let us take, for example, the case of a young man who seeks a position after a good college tr obtained in the majority of cases through great sacrifices on the part of the parents. He is asked, first of all, if he has had any experience. Being honest, he says "No." Nine times out of ten he is not even given a chance. If he is fortunate enough to be taken, he receives a salary which most office boys would refuse and at which any bellboy would sneer. Nevertheless, he works hard to obtain the practical knowledge which is the privilege of some of his companions, who gave up their studies when about fifteen years old, thinking themselves clever enough. At first, these companions, who have taken ten, fifteen, twenty years to acquire that wonderful practical knowledge, laugh at the poor collegian; later, they condescend to help him until they are surprised to find that the green man has mastered their knowledge in a year or two. One would naturally expect to see the young man's salary increased in ratio to his capacity and earn at least as much as his companions. Ah, no! He is still a junior and, although able to figure, design and (thanks to his college training) do two or three times as much work as his older companions, it is against the rules of the company to increase his salary. This young engineer has not even the chance of the expert mechanic, who is paid by piece-work, and certainly he has not the power of the union man, who can strike when an increase is desired.

Is not this state of affairs greatly due to the senior members of the profession who, when at the head of a department forget too easily the hardships through which they also passed? In the majority of cases the senior engineers could remedy the situation.

It is clearly the duty of us, engineers, to first of all show what we are doing and what we intend to do, and so obtain the confidence of the government and of the public at large. But to realize fully this situation we, engineers, must be very careful to avoid mistakes—especially unscrupulous projects involving a waste of public money. Unhappily for our profession, there have been cases, although isolated ones, I must admit, noticed by the public where engineers not worthy of the name have been but tools of politicians. I do not mean by this that engineers should be disinterested in the politics of their country; on the contrary, their faculty of being able to discern right from wrong should be wisely and generously put to the service of their fellow men in return for the privilege they enjoyed in receiving instruction in colleges, universities and technical schools erected at the public expense.

Referring to the ninth paragraph of Mr. Peters' article, dealing with the high ideals every engineer should possess, it must be understood that the executive committee of the Manitoba Branch especially invited four members to speak on the important subject of legislative enactments, two in favor of and two against. Although I was one of the latter, I am certainly in favor of some enactments which would eliminate the black sheep or prevent their introduction in our noble profession, thus giving the public a guarantee of the high standing of all its members. I do, however, believe that it would be preferable to proceed first with a complete organization of the engineering profession.

With the change of name of the Canadian Society of Civil Engineers to The Engineering Institute of Canada, and the adoption of the new by-laws, the time has come to earnestly put our shoulders to the wheel by organizing the provincial divisions and taking as soon as possible a census of all the professional men of each province engaged in any class of engineering work.

In order to simplify the work and at the same time have a good record of every professional man, I would

suggest that a printed card, say, the standard 3-in. x 5-in. file card, with an explanatory circular, be sent to all the above-mentioned men.

The front of the card might be printed as follows:—

"Name ....Birth date ....

"Birthplace ....Nationality ....

"Postal address ....Date.........

"Present position ....Date.........

"Date of admission to Can. Soc. C.E. ....

"Student ......Date ....Junior ......Date ....

"Assoc. member..... Date.... Member..... Date....

"Associate..... Date.... Hon. Member..... Date.....

"If not actually a member of the Can. Soc. of C.E., would you like to be admitted in the 'Engineering Institute of Canada'? ...... Yes...... No....... .

"If 'No' please state your reasons by letter.

"Education ....

"When completed ...."

The back, reserved for record, might be printed as follows:—

"Training and achievements after completion of education

....

.... ;.........."

On the return of these cards, preliminary classification could be made and a report sent to the council.

After the completion of the organization, such a record should be kept at the headquarters of each provincial division and every member should make it a rule to advise the provincial secretary of any change of address or position, not only for his own benefit but for that of the whole community.

Some members may object that such a record will be expensive to make and difficult to keep up-to-date. It must never be forgotten that similar records have made Germany the power that she has become. The time has come for each of us to show all concerned the immense advantage contained in such an organization and to teach them how to use it.

The time has come for each of us to get rid of that selfishness which is the real cause of the appalling misery actually brooding over the Old World and which will soon spread to the New if we do not join together to prevent it.

It may be said that this is comparatively easy; but we must also put all our might and give our best endeavors to extirpate this misery from the Old World. It is not only a point of honor to help this Old World, which has done so much for us, but a bounden duty to help in the reconstruction of a New World composed of men full of good will towards each other.

All we need to obtain this result is to utilize the tenth part of the energy displayed by our men in the trenches, to possess a fraction of their devotedness and faith in a bright future.

J. G. LEGRAND,
Bridge Engineer,
Grand Trunk Pacific Railway.

Winnipeg, Man., March 2nd, 1918.

Provincial Consulting Engineers

Sir,—I have been much interested in the remarks of Messrs. Wynne-Roberts and Adams, consulting engineers, in their discussion on provincial consulting engineering, and while your paper has already devoted considerable space to this interesting subject I would like to make a few observations regarding it.

Until we engineers as a coherent body bestir ourselves to demand and insist on occupying the position to which we are entitled and for which we are qualified, so long shall we continue to be hewers of wood and drawers of water for those whose aspirations are more pronounced and for the public which through our own fault fail to appreciate fully our services and merits.

It is generally admitted that the sciences have not been recognized from the commercial viewpoint, and that science, unlike law, dentistry and medicine, is in direct competition with the world. The principle of a close corporation may be either right or wrong, but if it is right then science should also have a corporation for the general betterment of mankind.

To place engineers on a proper basis it should be essential for a man to have a degree from a university approved by a body nominated by the universities and approved by the various scientific societies. It is only by unity between the university, its graduates and the various societies, that legislation can be obtained to solve the problems confronting us. I believe that legislation should come as a result of the initiative of the universities in a uniform demand. Loyalty to the Alma Mater would withstand any opposition from unfriendly quarters.

The appointment of the Scientific and Physical Research Commission under the chairmanship of Prof. McCallum is a step towards a more adequate recognition of science and it may be that some feasible solution may emanate from this worthy body, which is quite representative of the sciences.

In my judgment, the engineer who is employed by any government authorities as salaried official should not only be prevented from undertaking constructive private work himself, but should be made to feel that it is almost improper to do so.

There are exceptions, however, and I think that no hard and fast rule should be laid down in this respect.

There is no doubt that the engineer in the government, either in the inside or outside service, or even in any of our provincial governments, has no right to engage in any private practice, except it be for some worthy institution and where no fee is charged.

If an engineer or any civil servant engages in any other than his government work after the first complaint to the proper head, his position should be untenable.

A. JAS. MILDEN.

Cornwall, Ont., March 7th, 1918.

Over $60.000 was spent in bridge construction in Nova Scotia last year, according to the annual report of the Department of Works of that Province.

According to the new legislation which is being introduced in Alberta, all municipalities and local improvement districts will be put under a uniform type of government and will be called municipal districts.

Hon. Findlay Macdiarmid, Minister of Public Works, Ontario, has announced that under the Good Roads Act, $2,-543.000 had been spent upon the improvement of county roads and $107,000 on the construction of modern "object lesson" roads, $39,000 on the Provincial highway east of Toronto and $54.000 upon the maintenance of county roads.

REFUSE DISPOSAL*

By Rudolph Hering, M.Can.Soc.C.E.
Consulting Hydraulic and Sanitary Engineer, New York City

About 1860 London, being the largest city in the world, began to have trouble with the refuse, rubbish and garbage. The hauls began to be so long that this became very expensive. The same trouble appeared elsewhere in England and England was the first country to really take hold of this refuse question and study it thoroughly.

It was not until 1874, though, when Fryor, in Nottingham, constructed a special furnace for burning all this matter, much of which was formerly dumped or buried. This started the system of refuse incineration. It was crude, but it did the work. It caused an odor, offensive sometimes, because they did not know at that time just how to prevent it, but it was a start. Since then a series of improvements have been made and are continuing to the present time.

In the United States, Lieutenant Ryder was the first one to build one of these refuse destructors or incinerators. It was located on Governor's Island, New York, at the military fort.

At about the same time somebody in Vienna had suggested that as there was a lot of grease in garbage it should be separated and utilized. Of course, all the rest of the refuse had to be dealt with in some other way.

I do not know where the first plant of that sort was erected in the United States, but there are a number here now which we call reduction plants. Some have been successful because profitable, although not in every place. Generally they spread a very offensive odor.

In order to judge this subject properly it must be considered from three points of view. In the first place, we must endeavor to prevent the dissemination of disease, then we must prevent a nuisance, and thirdly, we must do both at a minimum of cost. Those are the three problems that the engineer has to solve.

Fresh garbage does not carry disease germs. We do not bring anything into our kitchens that is not healthy, and what we throw away is not unhealthy. But later, after the garbage has been standing in the pail, flies get on it and breed. The fly is a disease carrier, because, while it does not carry any disease from the garbage, it goes elsewhere, into privies, and where there are disease germs. It picks them up and flies into the kitchen, wipes its feet off on the bread and other foods. We do not know where the fly has been, but we do know that a great deal of disease has been transmitted in this way by flies. The only way garbage is responsible for disease is when it stays uncollected for a long time and is a fly breeder. As the garbage should be frequently collected, it should not be responsible for fly breeding. Ashes are not disease breeders, and there are no disease germs in ashes.

Then we come to rubbish. That is a dangerous class of refuse, because it includes discarded bedding from sick rooms, sweepings from rooms where sick people have been, and discarded clothing from sick people. Rubbish is really, as I think, one of the most dangerous parts of the city refuse, so far as disease carrying is concerned.

Manure is objectionable as a possible disease producer, because it may carry disease germs directly, more particularly in night soil coming from human beings. Manure also acts as a fly breeder. and the flies again do their part in carrying disease germs.

*Abstracted from Journal of the Western Society of Engineers.

Finally, street sweepings. When the air is very quiet the bacteria contained in it will settle down and fall on the surface of the street. Analysis has shown that the street dust retains a vast number of bacteria. Some of them are undoubtedly disease producing. For that reason the "spitting ordinances" have been introduced very broadly to prevent tuberculosis germs getting onto the sidewalks, from where the wind raises them up so that we breathe them.

That is the aspect concerning the prevention of disease.

Now, the nuisance question. Among the different classes of refuse, garbage is the greatest offender in this respect. Being dead organic matter, it is very soon attacked by bacteria of putrefaction, and putrefaction causes an offensive odor. In order to prevent this, we must see that the garbage is rapidly removed before bacteria can putrefy the organic matter.

Manure comes next, and we should dispose of it fairly rapidly to prevent offense.

Ashes are not offensive. They do not even make a nuisance excepting through the dust which, when raised by a wind, is objectionable in the neighborhood.

Street sweepings are like ashes in this respect. A wind storm, if the streets are not kept clean, lifts the dust into the air and causes a nuisance. Our modern system of cleaning streets by flushing is an excellent means of preventing such dust. In those European cities where they practice flushing there is no dust. Flushing is now used in New York, and I think partly here in Chicago and other cities. We are progressing in that line very nicely. Dust is a nuisance.

We have in the United States two general methods. One is the separation of the refuse material into two or more classes, and the other is the practice of combining everything and disposing of it together. We have a somewhat more complex problem than they have in Europe. The reason for this is really that we are very wasteful and throw away much grease with our food waste. When European engineers come over here and see how we waste our water, our electricity, and our food, they are astonished. We use at least twice as much water per capita here as they do in Europe, even in London, Paris and Berlin. We produce about twice the amount of garbage per head in this country that they do in Europe, and we throw away twice as much grease. There was only one place where they tried the separate, or, as they called it, the American system, and that was a city near Berlin, Charlottenberg. They abandoned it after five years, because it was not profitable.

In this country, where we are so extravagant, a great deal of stuff is thrown away that still has some value, and money can be gained by picking over and sorting the discarded refuse of a city. I saw them do it in London at a station on the Surrey side, right in the middle of the metropolis, at one of their incinerators. Everything was dumped on a moving belt. There were about thirty girls at work; some were picking out paper, some rags, some bottles. Each article was put into a large barrel and then sold. There was a little profit in it, but it was an unhealthy and very disagreeable occupation. I asked some of these girls whether they did not dislike this sort of work, and they said they did not; it was not any worse than a lot of other dirty work they might have to do, and they had eight working hours, after which they were entirely free and could do anything they pleased. Servants are engaged for practically the twenty-four hours, and in the stores women work about ten hours. Here they had three eight-hour shifts. The Boards of Health do not like this occupation, and I think the tendency in Europe is to

stop this picking everywhere. Picking is worth more here because we throw away more valuable things.

The Buffalo records show a profit, after paying all expenses, interest and depreciation, but it is very small—about two thousand dollars. It seems to me that we shall gradually come to think, as in Europe, that it is better to give up this little profit than to put up with all the disagreeable and dangerous features of the sorting plan.

There are various methods of final disposal for this refuse. There is the land dumping, which is the oldest method. We have been dumping from time immemorial, and we shall continue to do so where it is safe and economical, only we should do it better than it is ordinarily done. Dumps can be made entirely healthful. They can be properly arranged and regulated, with a man on the ground to indicate where the next load should be dumped. If we know what sort of material is coming we can have the loads with inoffensive material thrown over what is offensive, or we can borrow earth somewhere and spread it over the dump. There are many ways in which you can make the dump for much of a city's refuse acceptable, perhaps not right in the city, but near it. Materials like ashes can always be dumped, and rubbish probably also, provided it is covered.

Garbage has sometimes been dumped without objection when it is mixed with other refuse, but when raw it should never be dumped, because it will rot and cause trouble unless it is covered with earth within a short time.

Another common system of garbage and rubbish disposal is by shallow burial. That method of garbage disposal is very important because it is used in many cities, including Berlin, with a population of two and a half millions. Channels are plowed into the soil about 18 inches deep, the garbage and refuse is thrown in, and the soil filled over it. In the course of two or three years all putrescible organic matter is decomposed. We have had some experience with this method in Milwaukee. I examined the material myself after it had been buried one year, two years and three years. After three years you could find some tin cans, iron wire and resistant organic matter, like bones, that would not decompose, but all the offensive organic matter was gone. That is a very cheap method. It is particularly successful in Berlin, because the soil is quite sandy. It has made that land much more fertile than it was before. I think burial is one of our best systems, particularly for small cities.

There are two methods usually employed in large cities. The reduction method is used in most of our large cities in America. Various processes have been tried. The first one was a cooking of the garbage with steam, followed by the application of naphtha, which dissolved the grease and separated it from the garbage; the remainder is called tankage, a material that can be used as a fertilizer filler. The difficulty with this process has been that the offense was great and therefore that it was a nuisance. We therefore built the works away out of the city. That meant a long haul and expense to the city. In Milwaukee a study was made between this reduction method with a haul far out of the city and the incinerator method with short haul right in the city. It was found that the short haul made the latter system the cheaper one, although, had the hauls been alike, the former system would have been cheaper.

The chief profit derived from operating a reduction works is from the sale of grease, which has a market value of from 3 to 5 cents a pound and is used chiefly for soap and candle making.

The other system, the last one I shall mention for disposing of refuse, is incineration. It can be made entirely sanitary. Disease germs will never go through a fire, and if the temperature is high enough there never will be a nuisance, provided we keep the works clean, which is not difficult. It costs a little more money, but that money is well spent. Some incinerators are being surrounded with parks, with trees and flowers. I have found plenty of incinerators in Europe in the densest parts of the cities. We could have them here. I see no reason why there should be any objection, if we build and operate such works as we know how to do.

Ashes containing unburned coal assist very much in the incineration of refuse. In this country, as well as in England, it has been found that sometimes 25 per cent. of the ashes is unburned coal. That is the reason why incineration in this country and in England has proved successful. We can get a very high heat. The heat necessary for incinerators is at least 1,250 degrees and this temperature destroys all organic matter, and you are sure you will not have odors. It is usual to have an average temperature of 1,000 or 1,500 degrees. Sometimes there is carelessness in operation; that is, in feeding and stoking, which reduces the heat, and then unburned gases go out of the chimney and give an odor. That is one reason why some of the incinerators have been found objectionable. But these are no inherent difficulties. Trained firemen can operate properly constructed incinerators without producing offensiveness.

There have been many designs for incinerators since Fryor's. We have front-feeding, back-feeding and top-feeding furnaces. We have had hand feeding and mechanical feeding, where the garbage is brought to the furnace and dumped into a hopper and discharged upon the grates. We have also furnaces where the clinker is taken out by machinery, as in Savannah, Atlanta, San Francisco, Toronto, and other cities.

We find quite a number of mechanically operated furnaces in Europe and America. It pays to have mechanical equipment in large cities, because it is cheaper and cleaner. Of course, it also requires greater intelligence. All the best disposal systems, particularly in large cities, require intelligent supervision and intelligent labor. In fact, we want more intelligent labor in most of our modern improvements.

City refuse is the most heterogeneous mass of matter on this earth. It contains solids, liquids and gases of great diversity, metals, stones and organic matter in every possible condition of rottenness. This complexity makes it difficult to deal with. If you put it all together there is no better means of destroying its objectionable qualities than with fire. It converts the whole mass into two materials. One is steam and the other is clinker. Steam is valuable and has been utilized in several places for different purposes. In Europe it is used for making electricity to light the towns. In Westmount, Que., they light much of the town by electricity made from the combustion of the town's refuse. In Milwaukee they have converted the steam into electricity and used it on the pumps which flush the sewer crossings under the rivers; in England for pumping either water or sewage in a number of cities. I think there is quite a future in a further development in this direction, so as to get the full value of these products of refuse incineration.

The clinker is generally used profitably in Europe. Here it has mostly been disposed of for filling. In Seattle it was ground up, mixed with cement and made into building blocks. The new incinerator in Seattle is built from the clinker made at the works. In Europe they make flagstones for paving, blocks for street paving and all sorts of ornamental figures.

NEW FEATURES IN THE DESIGN AND CONSTRUCTION OF BITUMINOUS ROADS AND TREATMENT OF CONCRETE ROADS*

By Chas. M. Upham
Chief Engineer, State Highway Department, Maryland.

THE title of this paper would suggest that we are constantly evolving new designs and methods in the construction of roads and pavements. This, however, is scarcely borne out by the replies received from forty letters, sent out to various state highway commissioners, state highway engineers, and consulting engineers requesting notes on any new features in construction that have been developed within the past few years. Thirty-one of the thirty-five replies received state that practically no new features have developed in road construction during this time.

It seems that there has been no great change in the basic methods of construction, but that the progress has been rather in the development of details in construction and in the producing of better road materials. But even here, no radical developments or changes have taken place. Even if we went back four or five years, it would be difficult to find many new features worthy of serious attention that have not been tried out or developed in some part of the country at some time previous.

The trend of road construction in the past few years seems to have been an intensive development of the pavement of the general classes of construction that have been laid down and generally accepted for some time. There has been no great recent change in the general highway construction such as took place when the use of bituminous material became more popular, or when concrete started to be used as a highway surface. Some of the new developments and the details are, however, very important, for they are the means whereby excellent pavements are being produced at much lower cost than formerly.

In bituminous roads, the fundamental requirements are a dense aggregate bonded together by suitable asphalt. The bituminous roads of the mixed process can be generally grouped into two types, namely, asphaltic concrete type, in which the larger stone aggregate is used, and a pavement of the sheet asphalt type in which finer aggregate is used. There is still another pavement that greatly resembles these that creates still another type. This is made up of pulverized clay, or a very fine aggregate, saturated with bitumen.

Of the pavements of the type in which larger stone is used in the aggregate, very good results have been obtained by Mr. Dean in Massachusetts in his "gravel asphalt concrete." In this pavement the attempt is made by various proportionings to utilize everything in the gravel pit, either in the base course or in the wearing surface. A gravel base of four inches is generally used in the construction of this pavement. The base is thoroughly rolled and filled with sufficient screenings to fill the larger voids, but not come quite to the surface of the base stone. The size of the stone in the base course varies from ½ in. to 3 ins. The gravel asphalt wearing surface is prepared by heating the gravel aggregate and then mixing with the asphalt. The size of the aggregate is between ¼ in. and 1½ ins. and may constitute from 15 per cent. to 75 per cent. of the total pavement. The remainder of the aggregate would be sand from the same pit, the proportion being determined after an analysis of the gravel. The wearing surface is always spread from dump boards and then rolled until solid. The asphalt used is about 70 penetration and heated by steam coils. Massachusetts is now constructing a large mileage of this type of pavement.

Mr. Everett, of New Hampshire, has developed a new method of constructing asphaltic concrete which he calls "modified asphalt pavement." This is somewhat similar in the Massachusetts type, with the exception that the larger stone in the aggregate is always less than 15 per cent. This pavement resembles the Topeka mixture with the exception that there is an additional aggregate present larger than is used in the Topeka mixture. The grading of the aggregate is controlled by constantly testing the gravel and making up charts known as control charts. If the tests show that the aggregates are outside of certain limits, new proportions are immediately set.

The requirements of the modified asphalt pavements are as follows:—

Mineral aggregate

Passing 200-mesh sieve, from	5 to 11%
Passing 40-mesh sieve, from	18 to 30%
Passing 10-mesh sieve, from	25 to 55%
Passing 4-mesh screen, from	8 to 22%
Passing 1-inch screen, less than	15%

This method has been used for two or three years and is considered very satisfactory. This type of pavement is especially adapted to localities where there are numerous gravel pits.

Several new features have been added to some of the pavements of sheet asphalt type. One that has been reported as being very satisfactory is the use of ½-in. stone rolled into the surface of the sheet asphalt or Topeka pavement. This makes a pavement that is less slippery. Although this has but recently been tried out on a large scale, it has been tried out to my knowledge on a few very successful experiments about six years ago. At first glance it would be supposed that the ½-in. stone would soon wear away with the surface of the sheet asphalt, but as a matter of fact this stone seems to be driven into the surface as well as worn away. On a moderate traffic roadway it has been found that considerable of this ½-in. surface stone was still in the surface even after four years use. Probably the most successful way of applying this stone is to first heat the chips and apply them before the pavement has been thoroughly rolled, which then allows the stone to be slightly rolled into the surface. The size of the stone should be from ¼-in. to ¾-in.

Another pavement of the mixed type that is reported to have been successfully laid is one in which pulverized clay is used in the aggregate. This clay has the property of absorbing considerable asphalt, and in some samples as much as 16 per cent. of asphalt has been found. It has been claimed that the asphaltic material penetrates the clay until it is in a saturated condition, which makes the pavement practically waterproof and very dense. At first there was some difficulty in the physical making of this pavement, but I understand that this has now been overcome. It has been reported that this pavement has been successfully laid on an earth foundation.

A feature in pavement that has not been greatly used but very interesting on account of its being radically different from most pavements, is what is called "Strenolith." This is supposed to be made of sand, oxide of iron and resin. A few years ago a sample was submitted to our laboratory. It had the appearance of brown stone and was very hard. It had been used as a base somewhere in New York City, where, I understand, there is an entire

*Abstracted from paper read before the American Road Builders' Association.

block of this pavement. Very little is known of the exact analysis of this type or its practicability from standpoint of costs. In view of the increased price of materials of construction, it may be worthy of investigation and consideration.

There have been very few new features under the head of bituminous penetration. Among those that have been brought to notice is one devised by Mr. Shirley, of the Maryland State Highway Department, called "bituminous macadam."

The first course of the macadam is constructed as for a waterbound macadam. The top course is thoroughly rolled and compacted and then covered with a coat of trap rock screenings, varying from dust to 1-in. pieces. Upon this is spread a coat of tar, of the consistency that will run when cold, in quantities from .6 to .75 of a gallon per square yard. It is necessary that this tar be evenly distributed. Upon this tar material is uniformly spread another coat of screenings. This is then rolled until the entire surface presents a smooth and even appearance. The last coat of screenings is sufficient to prevent the tar from adhering to the wheels of the roller. After this has been spread and thoroughly rolled, there is applied .6 to .75 of a gallon of asphalt, applied cold. On this coat of asphalt is spread stone chips ranging from 1 in. to 1½ in. in size. This is rolled until the surface is smooth and shows no effects from the passage of vehicles. All the screenings or chips are applied from piles or wagons with shovels, and extreme care is taken in keeping the surface during construction free from ruts, depressions or waves. This construction has been used for about two years in Maryland and has been found to be very satisfactory.

Another penetration method has been developed by Mr. Hirst, of Wisconsin. The work is carried on similar to the waterbound macadam, except that the last course is not filled with screenings but nearly filled with stone chips. Into this is poured ½ gallon of light tar or oil and covered with ¾-in. chips, enough of the latter being put on to keep the roller from picking up the asphalt. After rolling, another half gallon of bitumen is applied and covered with more chips. After this is rolled it is covered with ¼ gallon of material and covered with small chips. It is stated that this work costs very little more than waterbound macadam, and offers an excellent foundation for subsequent bituminous treatment.

A few new features in bridge work that have helped to overcome the difficulty in keeping the plank floors of bridges in good condition have been recently reported. Several ways of treating plank have been evolved with only partial success. The location of many county bridges as well as their size, would not warrant an expenditure of any great amount for the construction of a protective coating over a plank floor. The use of an asphaltic concrete wearing surface made up of stone and of sand and an emulsfied asphalt has provided a means of providing at a moderate cost, a wearing surface for bridges that is both substantial and inexpensive. Many times the aggregate can be secured locally and the asphalt mixture made without heating. On account of the character of the asphaltic mixture, it can be put down by tamping it into place. The material may be mixed either by machine or hand.

The ingredients that are proving to be most satisfactory is a mixture of stone chips ranging from dust (¾ in.) with the asphalt. It is stated that this mixture readily packs under traffic and forms a mat that resists the wear of traffic. Considerable of this work has been done under ordinary conditions at 30 cents per square yard. The thickness of the mixture should be from 1 in. to 1½ ins.

In concrete road construction, several new features have been devised in the last few years. Probably the one that is now demanding the most attention is the use of a hand roller in the finishing of concrete. It is stated that slabs finished with the roller develop considerably more strength than slabs finished by an ordinary float. Not only does the roller increase the strength of the concrete, but it is stated that it also takes out the short waves that cause considerable vibration to traffic in passing over the pavement. A common way of manipulating the roller is to move the roller transversely across the pavement a certain period after it is struck off with the template. The effect of the roller is to consolidate the top layer of the concrete and remove the surplus water and take out the slightly uneven places that have been left by the template. Experience will best tell the right amount of rolling. After the pavement is rolled it is ready to be finished with a canvas belt.

In riding over concrete roads it has been found sometimes that there is considerable vibration or unevenness. This is a serious objection which should and can be overcome. On the roads that have been constructed for some time a good part of this was due undoubtedly to the fact that sufficient care was not taken in the finishing. It has been found that with extreme care with the template and in hand-floating that there are still numerous waves in the concrete surface, and it is stated that it is practically impossible to get rid of this. After experimenting with various finishes, it has been found that the smoothness and evenness of the surface is practically in proportion with the condition of the side forms. A form that keeps a true alignment and is not easily bent and can be kept in a straight line, is the one that will produce the smoothest pavement. It would indeed be a new feature to produce a form that will stand up and remain in good condition under the handling given by the contractor.

A new feature in the maintenance of concrete roads is the use of a tar kettle upon which is mounted a pump and hose. Considerable time is saved by the pump and hose and a large mileage of concrete pavement can be maintained in a short time.

In the construction of concrete roads, the use of hydrated lime has demanded considerable interest and attention. Many laboratories have done considerable experimenting, but for some reason have not written a great deal on this subject. It appears that hydrated lime does not have the same effect upon different proportions of concrete, nor does it have the same effect upon different sands. It also appears that the beneficial effects of hydrated lime are within certain limits. Of the sand used in Delaware the maximum benefit resulted when 4 per cent. of hydrated lime, by weight of the cement contents, was used. It appears from the results that lime is not as beneficial to the stronger or weaker proportions of concrete as it is to the intermediate.

In other words, hydrated lime is found to be beneficial to the strength of concrete when used within certain limits. The length of this paper being restricted, it will not be possible to go into the details of these tests.

It is not a new feature and it is practically now accepted by all engineers, that the aggregate in concrete should be mixed for at least one minute. Certain experiments seem to show that continued mixing increases the strength up to four minutes. It appears, however, that the most economic time is between one minute and one and a half minutes.

The question of joints seems to have been one that demands considerable attention, and it is now almost the general method to place a joint only at closing of work for

the day, or no joint at all. Many experiments have been carried out by connecting each day's work into one large slab without a limit to its length. While no bad effects have resulted from this, it does not, however, mean that transverse cracks are eliminated entirely. Inasmuch as it seems practically impossible to eliminate entirely these transverse cracks, it is considered good practice to so regulate and provide a place of weakness in the pavement by placing a blind wooden joint underneath the surface at intervals from 50 to 200 ft. apart. This regulates the location of the transverse cracks to a certain extent, and makes possible a straight line crack instead of an irregular one. As a word of caution, there is a danger of not getting the wooden joints vertical. This would have the tendency of one slab to rise above the next. One other method that seems to be satisfactory and will insure no possibility of one slab rising above the other is to tie the different slabs together by iron rods which have been coated with tar or asphalt. This allows the concrete to contract or re-expand, but will not let one slab rise above the other. In this case the joint is treated and maintained exactly the same as a crack.

In the construction of concrete, a new feature that has greatly reduced the cost of construction and assisted in producing a more perfect concrete road is the method of measuring the aggregates at the point of supply, and in carrying them to the concrete mixer in containers, holding one batch.

Upon arriving at the mixer, the concrete ingredients are dumped into the hopper in one operation and then mixed and placed in the regular way. This method does away with the placing of the aggregates on the subgrade which would mean that considerable of the aggregate is lost, and that the subgrade could not be kept in as good condition as with the central distribution method. It also means that the aggregates are kept much cleaner, which means that the finished concrete is so much better. It also means that the labor operation of loading the concrete ingredients from the subgrade into the hopper is entirely eliminated.

Several methods have been devised to carry out this system, but probably the most satisfactory one is the use of an industrial railway for hauling the containers which carry the aggregates to the mixer. The container is taken from the car and emptied into the hopper by means of a derrick attached to the concrete mixer.

We find fewer new features in materials than in the other branches of the work. One, although it cannot be considered as exactly new, but very important, is the use of the blast furnace slag. Many years ago this material was used only in certain districts. At the present time it is being used satisfactorily in all localities where it can be economically obtained. Not only is this material being used in macadam but it is also used in bituminous construction. At the present time there are successful pavements of bituminous wearing surfaces made up of slag screenings and asphalt.

The Lincoln County Council has asked that the Queenston-Grimsby road be designated this year as a provincial highway.

Important steps are to be taken by the Ontario Government to control the fuel resources of that province, according to a statement made by the Minister of Lands, Forests and Mines, who has introduced a bill which will give the government power to appoint a fuel controller or a commission, and will appropriate $100,000 for a thorough investigation into the fuel resources of the province. It is planned that the province should co-operate with the Dominion Government in all experimental work, in order to prevent overlapping.

DEFENDS CONSERVATION COMMISSION

James White, assistant to the chairman of the Conservation Commission of Canada, at the annual convention of the Canadian Mining Institute, held last week in Montreal, accused the latter body of sending to Sir Robert Borden a memorandum which, Mr. White alleged, was full of inaccuracies. He declared that unless there was an end to the "most scandalous and disgraceful attacks made on the Commission," he would place the matter before the Hon. Clifford Sifton, the chairman, and raise a question whether the Institute should continue to receive the grant from the Dominion Government.

Mr. White denied emphatically that the work of the Department of Mines had been encroached upon and that it could never get the necessary funds to carry out the work which the Commission had been encouraged to undertake.

He declared that from 1910 till 1916, $770,000 had been turned back to the treasury by the mines department as unspent, "yet the precious bulletin declared it could not obtain funds. The memorandum inferentially stated that power had been given the Commission by Order-in-Council to appoint permanent officials or employees in the civil service. Surely everyone knew that the government could not abrogate its powers in such a manner. The field work of the Commission in regard to mines and minerals had not aggregated one thousand dollars a year, and yet the Commission is told that it spent so much that the mines department had not the necessary funds."

As an indication of the good work done by the Commission, Mr. White said, they defeated the application for damming the St. Lawrence at the Long Sault by an alien corporation, and also an application under the guise of a canal charter which, if granted, would have alienated to a corporation all the water powers of the Pigeon, Rainy, Winnipeg and Saskatchewan Rivers, between Lake Superior and the Rocky Mountains. A flood of other water power legislation was withdrawn after that.

PROVIDE POWER ON GRAND RIVER

From time to time delegations have waited upon the provincial government of Ontario petitioning that some definite steps be taken to prevent the floods which occur each spring on the Grand River.

A few days ago in the Ontario Legislature, J. H. Ham, member for South Brant, again opened the question and urged the government to take some measures so as to prevent damage by flood along the river.

He claimed that not only could damage be prevented but the water could also be used for irrigation and power purposes.

Minister of Public Works Macdiarmid replied that while the government recognizes the seriousness of the matter and the fact that the river has power possibilities, he doubted the wisdom of building dams and reservoirs until such time as the Hydro-Electric Commission has completed its investigations.

The Hydro-Electric Commission has been conducting its investigations each season since 1913.

Since the Toronto-Hamilton highway was completed in October last, the traffic has increased by 60 per cent. The jump is mostly in pleasure motor vehicles, but the daily average of traffic rose from 520 in 1916 to 3,065 in 1918.

GENERAL PROFESSIONAL MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS

The first "general professional meeting" of the Canadian Society of Civil Engineers will be held March 26th and 27th, in Toronto. The subject under discussion will be the present fuel and power situation. Headquarters will be in the Theatre Lecture Room of the Physics Building, University of Toronto, and the meetings will also be held in that room.

Arrangements have been made for delegates to visit the plant of Canadian Aeroplanes, Limited, on Dufferin Street, or the plant of British Forgings, Limited, at the foot of Cherry Street. Those who intend to take advantage of these inspection trips are requested to notify the secretary of the Toronto Branch, Geo. Hogarth, 514 Markham Street, Toronto, in advance, stating which trip is preferred, so that arrangements may be completed. The parties will assemble at the Engineers' Club, 96 King Street West, at 9.30 Tuesday morning.

Following is the program:—

Tuesday, March 26th (Afternoon Session)

Opening address by Sir William Hearst, Prime Minister of Ontario.

"The Fuels of Canada," by B. F. Haanel, chief of fuel division, Department of Mines, Ottawa. Discussion by L. M. Arkley, M.Can.Soc.C.E., assistant professor of mechanical engineering, University of Toronto.

"Transportation from the Fuel Viewpoint," by W. N. Neal, general secretary of the Canadian Railway Association for National Defence, Montreal.

"The Rational Development of Canada's Coal Resources," by W. J. Dick, A.M.Can.Soc.C.E., mining engineer of the Commission of Conservation, Ottawa.

"Utilization of Peat," by John Blizard, A.M.Can.Soc.C.E., technical engineer, division of fuels and fuel testing, Mines Branch, Department of Mines, Ottawa. Discussion by James Milne, M.Can.Soc.C.E., mechanical and electrical engineer, Department of Works, city of Toronto.

"The Low Temperature Carbonization and Briquetting of Bituminous Coals," by E. Stanfield, division of fuels and fuel testing, Mines Branch, Department of Mines, Ottawa.

Evening Session

An illustrated address on "The Erection of the Quebec Bridge," by Geo. F. Porter, M.Can.Soc.C.E., engineer of construction, St. Lawrence Bridge Co., Montreal.

C. A. Magrath, Fuel Controller of Canada, has been requested to address the meeting on Tuesday evening, and it is hoped that he will be able to attend.

Wednesday, March 27th (Morning Session)

"Ontario's Efforts to Relieve the Fuel Situation," by Albert Grigg, deputy minister, Department of Lands and Forests of the Province of Ontario, Toronto.

"Wood as an Emergency Fuel," by E. J. Zavitz, provincial forester, Ontario.

"Gas for Light, Heat and Power," by Arthur Hewitt, general manager, Consumers' Gas Co., Toronto.

"Central Heating as a Means of Conserving Fuel," F. G. Clark, M.Can.Soc.C.E., chief engineer, Toronto Electric Light Co., Toronto.

"Oil Fuel and the Possibilities of Its Use," by R. W. Caldwell, chief mechanical engineer, Imperial Oil, Limited, Sarnia, Ont.

Afternoon Session

"Canada's Water Powers and Their Relation to the Fuel Situation," by J. B. Challies, M.Can.Soc.C.E., superintendent of Dominion Water Power Branch, Department of the Interior, Ottawa. Discussion by H. G. Acres, M.Can.Soc.C.E., hydraulic engineer, Hydro-Electric Power Commission of Ontario, Toronto.

"Railway Electrification," by John Murphy, M.Can.Soc.C.E., chief electrical engineer, Department of Railways and Canals, Ottawa.

"The Possibilities of the Relief of Fuel Consumption in Canadian Industry by the Increased Use of Hydro-Electric Energy," by J. M. Robertson, M.Can.Soc.C.E., director, Southern Canada Power Co., Montreal.

"The Possibilities of Lessening Fuel Consumption in Canada by the Adoption of Electrical Heating," by P. H. Mitchell, A.M.Can.Soc.C.E., consulting engineer, Toronto.

On Wednesday evening at 8 p.m. a smoker will be held at the Engineers' Club, 96 King Street West, at which refreshments and entertainment will be provided.

CONCRETE POLES FOR 22,000-VOLT LINE

Reinforced concrete poles are used for a 22,000-volt power line six miles long at Brentwood, California. This line supplies a load of approximately 2,800 horse-power. The poles are 41 feet long, 17 inches square at the base and 8 inches square at the top. The cross-arms were cast as an integral part of the pole. The spans vary from 250 feet to 390 feet. Commenting on this installation, the Electrical World, of New York, says:—

In this case, the permanency of the installation, with perhaps somewhat greater security against line trouble, was the deciding factor in the choice of reinforced concrete. The poles were designed as square, tapered beams, reinforced symmetrically on two sides. For economy of material, two sizes of poles were designed, the heavier ones to be used at each sub-station and for every fifth pole on the line as well as at crossings. The lighter poles served for the remainder of the work.

A striking feature of the construction is that the cross-arms were molded with the poles and the whole work of molding was done on the ground on account of the great weight of the finished pole, averaging about four tons. The forms were laid out horizontally, reinforcement was suspended in place, and the concrete was hand-mixed and molded into them. In the cross-arms the reinforcing is of steel angle irons, which carry the insulator pins directly so that even were the concrete to be broken from the arms, the stability of the conducting system would not be disturbed. After completion, the poles were erected by a double derrick mounted on a dray. The derrick was put in position, the pole caught just above its centre of gravity by a chain sling and the pole lifted on end and dropped into its hole.

The average cost per pole erected was a little less than $70, divided with fair equality between material and labor. The poles were designed with a high factor of safety, in fact so as to withstand a 90-mile wind with all the wires on one side broken, a condition thought considerably more severe than is likely to be actually encountered in the operation of the system.

ENGINEERING IN THE NAVY

Commander J. W. Skentelbery, R.N., a member of the British Institution of Naval Architects, will address the Canadian Society of Civil Engineers this evening at Montreal, on "Engineering Activities in Connection with the Work of the Navy."

There will also be presented by J. L. Busfield, A.M.Can. Soc.C.E., an abstract of the paper by Dr. W. Bell Dawson, entitled "Datum Planes Related to the Tide."

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Principal Contents of this Issue

OUR FUEL PROBLEM

Canada is not in a position to do without United States coal at present. With substantial factory production and heavy freight movement, for war purposes, the Dominion will next winter need as much coal from the United States as during past winters, despite rigid economy in consumption. Certain parts of Ontario have already suffered from lack of coal notwithstanding efforts to supplement the supply with wood. There is good reason to congratulate Hon. C. A. Magrath, the Fuel Controller, upon the way he has handled the coal situation during the past severe winter. He has worked quietly and effectively, and is in close co-operation with Dr. H. A. Garfield, the United States Fuel Controller. It is confidently hoped that as a result of these co-operative efforts, the Dominion will be able to obtain its full share of coal for the coming winter. This will be needed even if supplemented by local wood supplies.

Our fuel problem, however, is not a matter related only to next winter. With the continuance of the war, with the increasing shortage of labor, almost stationary production, and rapidly increasing consumption, we are confronted with a national problem which demands serious consideration and action. The distribution of the coal we obtain from the United States is an important matter. If that coal is going to Western Canada, while Ontario is short and the Alberta coal producers cannot find a market for their output, there would appear to be room for adjustment. The value as fuel and the production and distribution of Western Canada's coal constitute one phase of our fuel problem. The development of our peat bogs is another important phase; and the obtention of wood supplies for emergency purposes is a third factor. We should not deal with our fuel question in a day-to-day manner. We should face the probability of the United States being compelled at some time in the future to curtail materially, or stop altogether, the export of coal to Canada. The present is the time to consider the development of our fuel resources if for no other reason than insurance against future contingencies.

AGRICULTURE AND IRRIGATION

"A farm in the wilderness, pioneering on the frontiers of civilization, is a trial, a task and a hardship, quite apart from the economic objection that it offers the comparative minimum of production per unit of man power, and a limited power at that," said Noulan Cauchon, C.E., of Ottawa, in a very able address on "Planning National Recuperation," delivered recently at the "People's Forum" in Ottawa. The ideas outlined by Mr. Cauchon deserve the earnest attention of the Dominion Government in view of the possible early return of thousands of soldiers who will be urged to settle on the land. The homes offered to the veterans should be rewards for valor—not mere opportunities to eke out a bare existence by the hardest drudgery and the maximum of self-denial.

Reclamation and irrigation in the heart of many of our older settlements is the solution suggested by Mr. Cauchon. Before committing themselves to any scheme for the division of frontier tracts among the soldiers, the members of the Cabinet would be well advised to obtain a comprehensive report from the Irrigation Branch of the Interior Department regarding the possibilities of irrigation in the more settled districts.

One such irrigation project which has many desirable features has been planned by Mr. Cauchon for the Hamilton district. In his address he said that this and other similar schemes "offer opportunities for co-partnership settlements of returned soldiers, where the twenty-five hundred dollars per head, suggested as government assistance to them, would afford them the greater help, value, comfort and social amenities—good roads, doctors, schools, churches—a civilized home."

Here may be an opportunity for the civil engineers and town planners to aid in solving another national problem. They are the members of the community who can secure economy and efficiency in the design, construction, disposition and administration necessary for the control, use and development of land.

Quoting again from Mr. Cauchon's address: "The economic theory and practice for the nourishment of True Democracy is control—in the public interest—of the use and development of land, of water and of air—of the forests and the mines, and of the raw materials elemental and essential in the maintenance of life—national resources in fief; dispensed in equations of equity.

"Acknowledging conditions, the best policy to further development is one of more intensive cultivation and of denser population evenly distributed—small holdings—where the amenities of life will thrive more freely.

"The logic of this policy is the achievement of higher and more progressive standards of living, greater efficiency—reaping enhanced return from our labor, earlier freedom from debt, and the sooner securing resource and cumulative reserve for ourselves.

"Nations pay their debts in produce, in consequence of which our relief will be scaled in the time, manner, extent

and value of our production from natural resources and from industry—maximum production."

Our national recuperation will rely upon the efficiency of the development of our natural resources. Therefore the engineer will unquestionably have a large part to play in the formation of the country's future. "Recuperation is integral of sustained effort," says Mr. Cauchon. "It cannot be put off till after the war; it is part of war; it is the foresight of maintenance."

PERSONALS

Henry Stewart Van Scovoc has resigned as chief engineer of the Toronto-Hamilton Highway Commission to accept a position as manager of publicity, Canada Cement Co., Limited. Mr. Van Scoyoc was born and educated in Pennsylvania. He graduated from the University of Pennsylvania as a B.Sc. in civil engineering, and began his professional career as a chainman on the Pennsylvania Railroad. Later he was transitman for a contractor and in 1907 entered the city engineer's office, Altoona, Pa., and was placed in charge of street paving, sewers and surveys. He came to Canada in July, 1912, as inspecting engineer for the Canada Cement Co., Limited, and resigned that position in November, 1914, to take charge of the construction of the Toronto-Hamilton Highway. Mr. Van Scoyoc is an associate member of the American and Canadian societies of civil engineers, and a member of the American Society of Engineering Contractors.

British and Colonial Press Photo.

John McCallum, formerly reeve for Alvinston, has been appointed to the board of commissioners for good roads in the county of Lambton, Ont.

Ejnar L. Landorph, formerly engineer of water service with the Canadian Pacific Railway at Winnipeg, has been appointed resident engineer at Kenora.

Brigadier-General H. N. Ruttan, M.Can.Soc.C.E., formerly city engineer, Winnipeg, has retired from the command of his military district owing to ill health.

R. R. Mowbray, formerly reeve of the township of Pickering, Ont., was appointed superintendent of the good roads system for Ontario County, Ont., recently.

A. E. Warren has been added to the administration committee of the Canadian Railway War Board. He is the chief operating officer of the Department of Railways and Canals.

Lieut. Percy Roberts, Canadian Engineers, mentioned in despatches recently by Field Marshal Sir Douglas Haig, was formerly on the Montreal Harbor Commissioners' staff.

W. B. Champ has been appointed managing-director of the Hamilton Bridge Works Co., succeeding the late R. M. Roy. Mr. Champ has been secretary-treasurer of the company for many years.

S. T. Lewis, formerly transitman on the Canadian Pacific Railway, Edmonton, Alta., has been appointed resident engineer at Medicine Hat, Alta., to succeed C. G. Washbon, who has resigned.

Capt. W. M. Everall, A.M.Can.Soc.C.E., who has had two years service in France, and was formerly Dominion Government engineer, Port Arthur, Ont., has been appointed assistant engineer, British Columbia Public Works Department.

William Ramsey, formerly city engineer at Fernie, B.C., and more recently assistant road superintendent for the Canadian Pacific Railway in that district, has been appointed district engineer for West Kootenay under the provincial government.

Charles Sinclair, B.A.Sc., of Toronto, who went overseas as private in the Divisional Cyclists and subsequently secured a commission in the Imperial army, has gained his captaincy and majority on the field and has been awarded the Military Cross.

Sir Percy Girouard, K.C.M.G., D.S.O., whom the residents of British East Africa desire to have appointed military governor of the Protectorate, was born in Montreal and served on the engineering staff of the Canadian Pacific Railway prior to 1888, when he entered the British army.

A. R. Macgowan, A.M.Can.Soc.C.E., has resigned as superintendent, Canadian Government Railways, Edmundston, N.B., to join the staff of the Delaware and Hudson Company at Carbondale, Pa. Mr. Macgowan was born in Moncton, N.B., and has been in railway work since 1899.

C. C. Lapierre has rejoined the engineering staff of the Publicity and Promotion Department of the Canada Cement Co., Ltd., from which he resigned about a year ago to open an office in Quebec as a cement engineer. Mr. Lapierre was one of the first cement salesmen in Canada, having sold British cement here before the product was made in this country in any extensive quantity. He has been a well-known figure for nearly a quarter of a century at all road congresses and other engineering and contracting gatherings.

OBITUARIES

Lieut. James Garnet Scott, R.N.V.R., attached to the Royal Naval Air Service, honor graduate of the School of Practical Science, Toronto, '14, died suddenly on January 25th in England. Before going overseas he was in the office of the chief engineer of the new Welland Canal.

Flight-Captain Ralph H. Jarvis was accidentally killed at Spittlegate, England, on February 27th. He had been mentioned six times in despatches and received the Military Cross in November last. He was a graduate of the School of Practical Science, Toronto, and had been connected with the Grand Trunk Pacific and the Canadian Northern Railways, and later with the Toronto Harbor Commission.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

High Voltage Transmission Line Has Mile Span

Overhead Power Cables under 100,000 Volts Pressure to Cross the St. Lawrence River—Two Steel Towers, Rivalling in Height the Main Posts of the Quebec Bridge, Are 5,000 Feet Apart

By ROMEO MORRISSETTE,
Public Works Department, Canada, Three Rivers, P.Q.

FOR some years past, the Shawinigan Water and Power Co. has transmitted power across the St. Lawrence River near Three Rivers by means of a submarine cable, in order to supply its stations on the south shore, viz., Victoriaville, Broughton, Thetford Mines, Black Lake, Windsor Mills, etc.

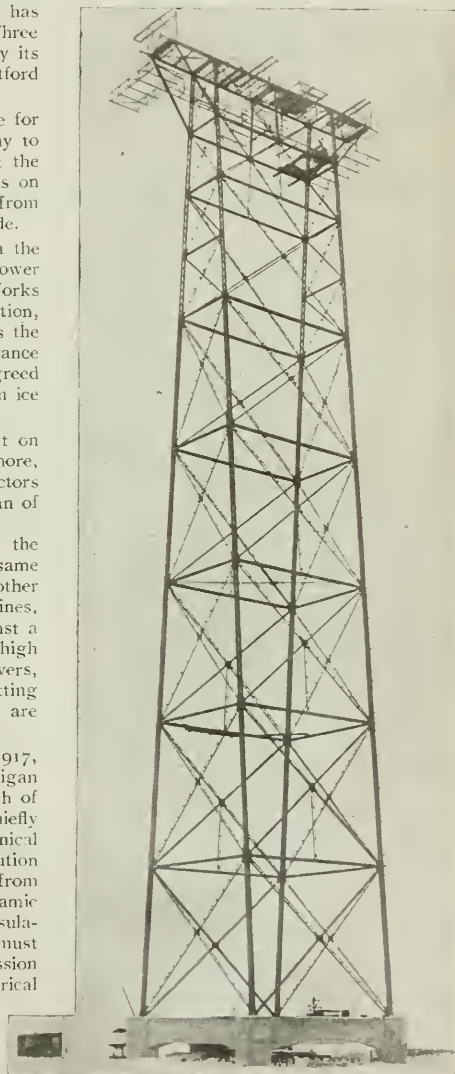
The increasing amounts of power required on the south shore for mining and industrial purposes made it necessary for the company to design an overhead high tension transmission line to supplement the existing submarine cable. The company has transformer stations on each side of the river about one and a quarter miles upstream from Three Rivers, P.Q., and at this point the river is over a mile wide.

Plans were prepared by the company's engineering staff in the winter of 1916-17 for two steel towers to carry the overhead power cables. These plans were presented to the Department of Public Works of Canada for approval. No objection was found to their construction, provided that sufficient clearance be left over the ship channel. As the river is navigable for the largest ocean vessels, a minimum clearance of 160 feet above water level was specified, and the company agreed to keep the power lines 160 feet above water level under maximum ice loading of the conductors in the spring or fall.

The towers weigh approximately 200 tons each and are built on concrete piers. Each pier is built approximately 500 feet from shore, and the distance between the piers is 5,000 feet, so that the conductors have a clear span of that length. This is the longest known span of its kind.

The towers carry three electrical conductors, made up of the highest grade of plough steel, spaced 50 feet apart, all in the same horizontal plane and arranged so as to prevent contact with each other when swinging. In order to connect with existing transmission lines, the conductors have to be insulated from the steel towers against a difference of potential of 100,000 volts. Because of the very high tensile stresses in the cables, they will not be anchored at the towers, but will be supported on the top of the towers by saddles permitting of the necessary movement due to temperature changes, and are anchored to concrete blocks some distance behind each tower.

In an article in *The Canadian Engineer* for May 10th, 1917, Frederick T. Kaelin, E.E., assistant chief engineer of the Shawinigan Water and Power Co., to whom the author is indebted for much of the information presented in this brief description, which is chiefly given to explain the accompanying photograph, said that the mechanical problems of this arrangement of anchoring permit of easier solution than do the problems of the electrical insulation of the conductors from the earth potential of the anchorage. The magnitude of the ceramic and mechanical engineering problems involved in this electrical insulation can be appreciated when it is considered that each conductor must provide mechanical strength of more than 100,000 pounds in compression due to the tension of the cable, besides providing for the electrical stress of the 100,000-volt transmission potential. The arrangement of the insulation also must permit the replacement of any portions showing electrical failure, without hazarding the mechanical safety of the anchorage. An elaborate arrange-



ment of porcelain insulators of new type, held in compression only, has been designed to fulfil the conditions.

The construction of the steel towers was started in May, 1917, as soon as the freshets were over, and the northern tower, of which a photograph is presented herewith, is now completed. The concrete work was done by day labor under the direction of H. G. Huber, superintendent of the Shawinigan Water and Power Co. The structural steel was fabricated and erected by the Canadian Bridge Co., Limited, of Walkerville, Ont.

The towers are 350 ft. high, which is approximately the same height as the main posts of the Quebec Bridge, this great height being necessary in order to get the desired clearance above water level.

Four concrete piers, sunk in caissons, form the footings for each tower. These piers are cylindrical, 11 ft. in diameter and 65 ft. deep, 40 ft. of which is below river bottom. Above the water level the piers are tied together by concrete struts, forming a square 60 ft. x 60 ft.

Active work will begin at an early date on the construction of the southern tower, and it is planned to complete the whole work during the coming summer.

SCHEDULE OF CHARGES FOR ENGINEERING SERVICES

RECENTLY Edmund T. Perkins addressed a meeting of the Illinois Society of Engineers and submitted the following schedule as a suggestion of what should constitute reasonable compensation for engineering services:—

The various services rendered are classified as follows, and are generally charged for on a percentage basis, except surveying which should be per diem: Reconnaissance, preliminary reports, surveying, plans and specifications, details, supervision and progress estimates, superintendence, alterations, professional advice, consultation, court work or arbitration.

Reconnaissance work is necessary when no data, or incomplete data, have been secured, and is preliminary to general planning of project and securing of data.

Preliminary reports are made when the necessary data on which the report is based have been secured of such detail and accuracy as to permit of proper advice being given or design made.

Surveying covers every class of field work which is not a part of reconnaissance work. It includes all location lines for roads, canals, railroads, etc., all level lines, all sinking of wells or experimental work, besides all classes of land surveying and land subdivision, and compensation therefor should be on a salary or per diem basis with expenses paid.

Plans and specifications are required as the basis for letting of contracts or for the information of the owner, employer or consulting engineer, and afford a full description of the work. They are implied by the necessities of the work even when not required by the owner, and include an estimate of the cost of the work. Plans, when adopted and approved, must be so endorsed by both owner and engineer.

Details are not always an essential of the construction work, and the rate charged, therefore, is flexible, varying with the amount of detail work.

Supervision and the making of progress estimates should always be required, that the engineer responsible for the plans and specifications should be satisfied, by personal inspection that the specifications are fully complied with and satisfactory progress made. When superintendence is paid for, as defined in the next section, there is no additional charge for supervision.

Superintendence of construction must be had by a superintendent mutually acceptable to owner and engineer. The schedule rate for superintendence applies when the engineer who has designed and planned the work, or his assistant, superintends construction. All other employees than such assistant or assistants are to be paid by the owner.

Alterations may be required at any time by the owner, or become necessary by reason of unforeseen conditions or changes in the size of projects. The schedule rate applies to such alterations as may be required by the owner —alterations becoming necessary by reason of unforeseen conditions or accidents are covered by percentage charges on the aggregate costs.

Professional advice is always charged for according to interests involved, charges being based on value of services rendered, not on time required in arriving at conclusions or opinions.

Consultation with engineers who have made certain branches of professional work a specialty may be requested by the engineer having general charge of the work, or may be required by the owner. Charges for consultation work being based on value of services rendered, not on time required in arriving at conclusion or opinion.

Court work as an expert or as arbitrator in settlement of controversies, condemnation proceedings, etc., in the interest of the owner, is entitled to additional pay at a rate to be agreed upon.

Schedule rates cover compensation only for engineering services; that is, the services of the engineer and his engineer assistants.

All expenses incurred for materials, blue prints, or for transportation, hire of helpers, rodmen, chainmen, teamsters, conveyances, and living expenses when away from regular place of business, are a separate and additional charge against the owner, as is a reasonable charge for general office expenses.

Time of payment is according to agreement; but usually is arranged on the basis of a preliminary payment, or retainer, and an advance for travelling or other expenses aside from services; and further payments on account, if the commission extends over considerable time.

Final pay for preliminary reports is due upon presentation of report.

Final pay for reconnaissance work is due upon completion of same.

Pay for supervision or superintendence becomes due on progress estimates made for payments to contractors, or, if work is done by day labor, on monthly appraisements of work done.

All percentages are computed on the contract price or actual cost of work.

When construction covered by plans and specifications is not carried out, pay for these plans and specifications is due upon completion of the estimate of cost of work.

The several items of payment on the percentage basis become due from time to time when the class of service has been rendered.

Per diem rates apply to an 8-hour day. Extra time is charged for on a basis of 1½ time on week days, and twice time on Sundays and legal holidays.

Table of Charges—On Percentage Basis

	Less than $5,000.	$5,000 to $10,000.	$10,000 to $20 000.	$20,000 to $50,000.	$50,000 to $100,000	$100,000 to $200,000.	$200 000 to $500,000.	Over $500,000.
	%	%	%	%	%	%	%	%
Reconnaissance .	2.0	1.75	1.5	1.0	0.75	0.5	0.4	0.3
Preliminaries ..	1.5	1.0	0.8	0.6	0.5	0.4	0.3	0.2
Plans and specifications	4.0	3.5	3.0	2.5	2.0	1.5	1.3	1.2
*Supervision ...	2.0	1.8	1.5	1.3	1.1	1.0	0.8	0.6
*Superintendence	5.0	4.5	4.0	3.5	3.5	3.0	2.8	2.4
†Alterations	7.0	6.5	6.0	5.5	5.0	4.5	4.0	3.5
Everything from beginning to completion of job	12.5	10.75	9.3	7.9	7.4	6.0	5.3	4.2

*Supervision not charged for when superintendence is.

†Alteration relates only to value of work involved in the alteration.

Note—Percentages are computed upon the entire cost of the completed work, exclusive of engineering, or upon the estimated cost pending execution or completion of same. "Cost" refers only to such part or parts of the whole work or project as the engineer may deal with.

Table of Charges—On Per Diem Basis

Chief engineer—$500 retaining fee, $100 a day while absent from office and expenses.

Assistant chief engineer—$50 a day while absent from office and expenses.

Topographers, assistant engineers and chiefs of parties—$15 to $25 a day while absent from office and expenses.

Designers—$12.50 a day while absent from office and expenses.

Instrumentmen, draftsmen, computers—$7.50 a day while absent from office and expenses.

Stenographers, chainmen, axmen—$3.50 a day.

Note—Attendance at court or expert testimony for any fraction of a day is considered as a full day.

Charges on Other Bases

A fixed fee for services rendered may be charged by agreement where a long engagement for professional services is contemplated, the engineer may accept such retainers on a yearly basis, at a compensation not less than that of the permanently employed engineer of the client. Except in cases where the compensation of the engineer is in the form of an annual retainer, the agreement between the engineer and his client should specify the period of time during which the compensation of the engineer, as determined by per diem charges, fixed fee, or agreed percentages, shall apply. If, through no fault of the engineer, the work should not be completed within the time so specified, an additional charge may be made, the basis for which, if practicable, should be agreed upon in advance.

Several prospectors have been at work in the Kingston, Ontario, district, and think they have discovered coal deposits, located within a dozen miles of the city. Samples have been submitted for analysis.

Hon. Howard Ferguson, Minister of Lands, Forests and Mines, Province of Ontario, stated at the Provincial Legislature last week, that the price of peat, as compared with coal, is as high as it has ever been, considering its relative fuel value. This is because the cost of manufacturing has advanced so much. The Ontario Government intends to endeavor to secure some labor-saving device for the production of peat in commercial quantities.

FILTER ALUMS USED IN ONTARIO*

By G. E. Gallinger, A. V. DeLaporte and F. A. Dallyn

The development of water purification in the province, and more especially the introduction of rapid sand filter plants, has brought new and peculiar duties to the Board of Health. At present an important matter under consideration is the quality of alum or sulphate of alumina offered for sale for water purification purposes. It is extremely necessary that a proper or satisfactory aluminum sulphate should be used in connection with the operation of mechanical filters.

For the past ten years the smaller municipalities in Ontario have been purchasing alum to satisfy their local requirements—amounts ranging from two to twenty tons per annum—through local supply houses or druggists. The importance of the filter alum supply has recently been greatly enhanced through the completion at Toronto of a water purification plant requiring the purchase of from 700 to 900 tons of alum per annum.

The investigation of the various filter alums supplied through the local agencies was undertaken by the staff at the laboratory at the Board's Experimental Station. The return of inquiry sheets showed, with few exceptions, that the alum supplied to smaller municipalities had passed through four or five hands before reaching them, and that the price paid by adjoining municipalities for aluminium sulphate varied widely. During the last two years the prices have varied from 1.9 cents to as high as 7 cents per pound, depending on the amount purchased; the latter represents the prices when purchased in small quantities.

Apart from the economic question of added cost, there is grave danger, when the local agency is unaware of the source of supply, that alum furnished in this way may be found unsuitable for the purpose of water purification. Several striking incidents of this nature were discovered during the laboratory investigation.

The investigation also revealed the fact that the average municipality purchased its alum without a knowledge of what was required.

The analysis of the alums received by the Board appear in Table No. 1.

Lump alum or sulphate of alumina is a combination of bauxite—a southern clay containing 58 per cent. to 60 per cent. alumina, the aluminum being present as $Al_2O_3H_4$, with sulphuric acid.

The process most generally employed for manufacturing sulphate of alumina consists firstly in mixing bauxite with sulphuric acid in lead-lined tanks, then boiling for a period of from six to eight hours. The solution formed after the reaction between bauxite and acid has taken place, is a mixture of $Al_2(SO_4)_3$ and silica; and in order to obtain a clear solution it is necessary to filter the mixture. This filtering process is difficult, tedious and costly. The alum solution is next boiled to expel the excess water. After being concentrated from a density of 25° or 30° Baume to a density of 50° or 60° Baume, the solution is discharged into trays, and on cooling it crystallizes to alum cake. This cake is then crushed or pulverized and is shipped in bulk, barrels or sacks.

A good basic aluminium sulphate should be in lumps from one-half to two inches in diameter. It should contain not less than 17 per cent. of water soluble aluminium calculated as Al_2O_3, and should have a basicity ratio of 0.03 or, in other words, should contain one-half of one per cent. of Al_2O_3 more than is theoretically required to

*From the 1916-17 annual report of the Provincial Board of Health, issued February, 1918.

combine with the sulphuric acid present. It should not have more than one per cent. as total iron. An excess of bases over the amount required to combine with the total acid present is a necessity and is a point that is overlooked in the purchase of alum by most municipalities.

Table No. 1.—Analysis of Filter Alums Offered for Sale in Ontario and Used 1916-1917

Source of Filter Alum (Municipality)	Al_2O_3	SO_3	Basicity ratio	Fe_2O_3	FeO	Insoluble matter	NH_3
Toronto, July 13th, 1917	19.5	38.6	.138	0.375	0.34	trace	....
Toronto, Aug. 8th, 1917	19.5	37.6	.015	0.4	0.37	0.4	....
Perth	19.4	40.6	.06	0.275	0.23	0.079	....
St. Thomas	19.3	39.0	.10	0.4	0.37	0.1	....
Toronto, Sept. 12th, 1917	19.3	32.2	.3	0.46	0.41	0.056	.05
Dundas	18.8	43.3	.02	0.3	.0.25	trace	.03
Toronto, July 24th, 1917	18.7	38.9	.011	0.4	0.37	trace	.04
Toronto, July 31st, 1917	18.7	41.2	.025	0.5	0.47	trace	....
Haileybury	18.7	38.0	.01	0.3	0.28	0.1	.03
Toronto, Aug. 31st, 1917	18.64	33.7	.25	0.58	0.53	0.07	.028
Lindsay (lump)	18.56	38.2	.128	0.47	....	0.2	....
Renfrew	18.2	38.6	.098	0.35	0.31	0.075	....
Cobourg	18.2	36.3	.16	0.3	0.27	0.05	....
Toronto, Sept. 19th, 1917	18.1	33.0	.24	0.58	0.54	nil	1.1
New Toronto	17.9	32.7	.022	0.40	0.05	6.4	....
Toronto, Sept. 12th, 1917	17.9	32.9	.23	0.45	0.40	0.08	.028
Iroquois Falls	17.8	32.0	.286	0.58	0.57	0.24	.05
Orillia	17.7	37.9	.094	0.35	0.345	trace	....
Stratford	17.7	38.3	.08	0.3	0.26	trace	....
Lindsay (ground)	17.6	38.7	.06	0.495	....	0.25	....
Kitchener	17.5	39.8	.01	0.3	0.22	0.1	....
Toronto, Sept. 27th, 1917	17.4	32.9	.21	0.45	0.43	0.23	....
Toronto, July 10th, 1917	17.2	38.0	.059	0.3	0.27	trace	....
Toronto	17.0	38.5	.035	0.3	0.21	0.1	....
Toronto, Aug. 2nd, 1917	16.9	36.6	.089	0.45	0.42	0.1	....
Weston (ground)	16.48	32.7	.14	0.01	0.005	0.16	....
Niagara-on-the-Lake	15.8	37.2	.01	0.5	0.4	trace	.026
Weston (lump)	14.0	33.2	free acid 1.1	0.04	0.03	0.12	....
Dunnville	12.8	35.5	0.1	trace	trace	trace	4.5
Maximum of each part	19.5	43.3	.300	.58	.57	6.4	4.5
Minimum of each part	12.8	32.0	free acid 1.1	trace	trace	nil	nil

NOTE.—Aluminium Sulphate should be judged and purchased on its water soluble aluminium content and on the excess of $Al_2O_3H_6$ over what is required theoretically to combine with sulphuric acid. Estimated on the basis of 17% Al_2O_3 at 2 cents per pound, an alum, 19.5% Al_2O_3, is worth 1/3 cent more, which is equivalent to a discount of 16½ per cent., and an alum 12.8% Al_2O_3 is worth ½ cent less and represents a loss of 25%. The 12.8% Al_2O_3 referred to was purchased at 5 cents per pound, and the loss was at least 1¼ cents per pound irrespective of the original high cost.

To insure quality in aluminium sulphate and to make an appreciable saving, the municipalities using chemicals and filtering their water should combine with each other and either manufacture their own aluminium sulphate or purchase it by annual contract according to the proposed specifications from one of several manufacturers. Without introducing the economic aspects of the question, the benefits to be derived from this co-operation are most apparent when the municipalities realize that manufacturers can give them exactly what they require with possibly a reduction in the cost of manufacture, provided the quantities and dates of shipment are reasonably apparent in the annual contracts. Until such action is taken the purchasing agent for each municipality should be instructed, even when buying small quantities of aluminium sulphate, to secure one which fills the following specifications:—

Table No. 2.—Estimate of the Present Use of Alum for Water Purification in Ontario

Municipality	Pounds alum used per annum	Water gallons pumpage per annum	Water pumpage per 24 hours	Pounds alum used per 24 hours	Estimated grains alum per imp. gallon
Abitibi Pulp and Paper Mills, Iroquois Falls	14,400	94,900,000	260,000	40	1.1
Amherstburg (projected)	....	....	750,000	106	1.0
Arnprior	300	146,000,000	400,000	52	1.5 (not in use)
Chatham	40,000	474,300,000	1,300,000	110	0.6
Cobourg	13,000	3,723,000	1,002,000	36	0.26
Dundas	17,155	117,530,000	322,000	47	1.1
Dunnville	6,000	182,500,000	500,000	15	0.2
Haileybury	45,000	73,000,000	200,000	125	4.4
Kitchener	14,600	261,250,000	312,000	40	0.9
Lindsay (under construction)	58,000	....	1,152,000	160	1.0
New Toronto	64,000	....	1,250,000	175	1.0 to 0.75
Niagara-on-the-Lake	3,400	73,000,000	200,000	9.5	0.33
Ojibway (projected)	50,000	....	1,000,000	140	1.0
Orillia	45,600	200,750,000	700,000	125	1.38
Oshawa (in construction)	22,800	159,610,533	438,000	62	1.0
Perth	18,000	200,000,000	500,000	50	0.7
Renfrew	9,660	371,500,000	1,017,882	26.5	0.35
St. Thomas	5,400	622,744,480	1,815,820	150	0.58
Stratford	25,000	372,700,000	10,204,640	69	0.49
Toronto	1,600,000	10,950,000,000	30,000,000	4,384	1.1
Weston	3,600	55,000,000	175,000	10	0.4

Specifications for Filter Aluminium Sulphate

The basic aluminium sulphate shall be in lumps from one-half to two inches in diameter and shall contain not less than 17 per cent. water soluble aluminium calculated as Al_2O_3. It shall have one-half to one per cent. of Al_2O_3 in excess of the amount theoretically required to combine with the sulphuric acid present. It shall not contain more than seven to ten per cent. insoluble matter in cold water and not more than one per cent. total iron.

Provided that a proper grade of bauxite filling the required specifications for alum-making is used, manufacturers should not find it difficult to supply aluminium sulphate according to the above specifications.

In paper mills, or for other industries where the pure article is needed, it is essential to use a sulphate of alumina containing not more than one-tenth to one per cent. insoluble matter in cold distilled water. For water purification, however, a refined alum is not necessary, and, in fact, it is not nearly so active a coagulant as alum containing a fairly high percentage of insoluble matter.

Table No. 2 is an estimate of the present use of alum and the dosage administered in the several municipalities operating rapid sand filters. It is to be observed that quantities greater than 2.5 grains per gallon and less than 0.5 grains are either excessive and wasteful, promoting corrosion in water service pipes and fittings, or inadequate, permitting insufficiently treated water to pass through filters.

Table No. 3 is a rough forecast of the use of alum in the province, mention being made only of the municipalities using alum at the present time. This table may be of interest to industries in a position to manufacture alum, or capable of supplying an equally satisfactory substance for the use of water purification plants. The number of municipalities employing rapid sand filtration should, in a few years, be considerably increased and the amount of alum used in the province for water treatment will be about 1,500 tons per annum.

Table No. 3.—Forecast of Use of Filter Alum in Ontario

Year.	Estimated pounds of alum used.
1916	1,891,115
1920	2,220,725
1925	2,673,610
1935	4,560,381

This decided increase in alum consumption, together with the problem of a suitable quantity of alum at a nominal cost, makes it highly desirable to consider the practicability of manufacturing filter alums within the province.

At the present time there is only one firm, to our knowledge, manufacturing alum in Canada. Most of the filter alum used in Ontario is imported either from Great Britain or the United States. A plant for making alum to coagulate water was recently built at the Columbus Water Purification Works, Ohio. According to Charles P. Hoover (Journal of American Waterworks Association,

December, 1915) this plant (1915) is a success both technically and economically, and between 800 and 1,000 tons of alum are manufactured per year. The cost of manufacture in 1915 was about $10.50 per ton. For this process sulphuric acid of not less than 92 per cent. is used and a bauxite containing not less than 52 per cent. Al_2O_3, and not more than 3 per cent. Fe_2O_3. Bauxite can readily be secured, containing from 58 to 60 per cent. Al_2O_3. The filter alum should contain at least 17 per cent. Al_2O_3, and one ton of bauxite will serve for at least three tons of alum, $Al_2(SO_4)_3$ 14 H_2O. The manufacture of alum in Ontario at the point where it is to be used would be of great economic advantage, especially in that it increases our local market for sulphuric acid wherever large quantities of filter alum are required, and this coincides very well with the points of manufacture of sulphuric acid; also there is a decided advantage in hauling less than one-third the tonnage over railways now known to have very congested traffic conditions. Alum made at some central water purification plant can readily be shipped to adjacent municipalities in a solid form.

The importation of bauxite would probably be from the Southern States of America where it is mined quite extensively. There is no record of any bauxite in Canada. The shales and clays of Ontario seldom give as high as 20 or 21 per cent. Al_2O_3 and except the ordinary process is to be changed, are not suitable for the manufacture of alum.

WATER CONSUMPTION STATISTICS OF SEVERAL CITIES

The following table showing the estimated population, the daily per capita consumption and the percentage of services metered will be of interest. These figures were obtained from the officials of the various cities and are taken from the report of the Chicago Bureau of Public Efficiency.

City.	Estimated Population.	Average daily consumption per capita (gallons).	Percentage of services metered.
Des Moines, Iowa ...	105,000	60	98.5
Providence, R.I.	284,400	66	93
Oak Park, Ill.	33,000	70.6	100
New Orleans, La. ...	378,000	75	100
Madison, Wis.	32,050	77.4	99.8
Atlanta, Ga.	200,000	89	100
Kansas City, Mo. ...	380,000	89.5	80
Columbus, Ohio	216,687	90.5	96.1
Omaha, Neb.	180,000	95	87.6
New York, N.Y.	5,602,000	101	26.8
Boston, Mass.	762,700	105	66
Springfield, Mass. ...	106,280	106	97.7
Cleveland, Ohio	845,000	113.2	98.4
Milwaukee, Wis. ...	440,000	118	99
Cincinnati, Ohio	415,000	126.3	69
St. Louis, Mo.	755,000	130	7.1
Washington, D.C. ..	364,088	136.5	77
Los Angeles, Cal. ...	533,535	140	88
Detroit, Mich.	781,133	168.5	36
Philadelphia, Pa.	1,700,000	176	15
Chicago, Ill.	2,491,933	258.9	6.9
Buffalo, N.Y.	486,000	329	5

The following have been nominated as officers of the American Water Works Association for the year 1918-1919:—For president, Chas. R. Henderson; vice-president, Carleton E. Davis; treasurer, James M. Caird; trustees, Allan W. Cuddeback and John J. Hinman, Jr.

SEWAGE TREATMENT AND DISPOSAL*

By G. Bertram Kershaw, M.Inst.C.E., M.Am.Soc.C.E.
President of the Institute of Sanitary Engineers.

THE first point requiring consideration in sewage treatment is the nature of the sewage to be treated.

Sewages differ very widely as regards strength and composition, scarcely two being alike, and it is of vital importance to obtain a thorough knowledge on these points. Sometimes this knowledge can only be tentatively arrived at; usually, however, samples can be taken and analyzed. These samples should be what are known as average samples, or samples drawn according to the rate of flow; otherwise very misleading results may be obtained. A very rough idea of the strength of a domestic sewage may doubtless be obtained by a knowledge of the sewage flow per head of the population sewered; but I would utter a word of caution against placing too much reliance upon this. It by no means follows that a 30-gallons-per-head sewage is necessarily twice the strength of a 60-gallon sewage, even when two domestic sewages are compared. Sewages often differ very considerably as regards oxidizability, even when the water supply per head is similar, and when trade wastes are present the flow of sewage per head may be comparatively little value as an index of strength. The proper way to determine the strength of a sewage is by a series of analyses, and the use of the proper formula for strength.

On the nature of the sewage as shown by the figures of analysis will depend in great measure the nature of the treatment to be adopted; generally speaking, the constructional cost and working charges will vary directly as the strength of the sewage. Even when the treatment works are in active operation, samples should be taken and examined, especially when trade wastes are present; the strength and character of a sewage does not, as a rule, remain constant year after year, and it is well to ascertain from time to time how far and in what way it has altered. One factor alone, *viz.*, the setting up of new manufactories in a town, may entirely alter the composition of the sewage. During the past three years large munition works and huge extensions of existing factories have not only modified but absolutely changed the character of many sewages.

With respect to analyses of sewage liquors (the term "sewage liquors" including effluents), it has always seemed to me that figures taken to four places of decimals are utterly out of place, and tend to give a fictitious appearance of great accuracy, which is seldom justifiable. Again, figures of analysis regarding the water supply itself should, whenever practicable, be given, together with the figures for the sewage. The water forms the bulk of the liquid portion of the sewage; chemically it varies very considerably, and it is often important that its chemical characteristics should be known.

Conjoining with the sampling of sewage liquors, and equally important, is the gauging of sewage flows, and it is often convenient to carry out both operations at the same time. It would be of great assistance in many ways to sewage engineers if greater facilities for gauging were provided at all sewage works, no matter how small, yet it is rarely the case to find such provision. It is no answer to point out that gaugings have been taken for years in the case of a few large works; it is the average works that needs improvement in this respect. Gauging records, when worked up, would give much valuable information.

*Abstracted from Presidential Address.

Passing on to the removal of the larger suspended solids from sewage, the question of screens arises, and I think it will be found that screening in this country is practically confined to what may be termed coarse screening, intended—apart from the protection of pumps, filter presses, etc.—to remove only the larger solids, such as sticks, rags, corks, and the like, which would otherwise be apt to cause trouble by lodging under valves or sluices. Such coarse screening is to be regarded as a mechanical process of abstraction rather than of purification.

Although the amount of material removed by comparatively fine screens (⅜ in. to ¼ in.) may appear large to the eye, it will generally be found when dried to represent on the average considerably less than 10 per cent. of the total suspended matter present in the sewage, while the impurities in solution are practically unaltered, or may even be increased by the screens.

Comparatively recently attention has been directed in America and elsewhere to what is termed fine screening, by which is meant screens having openings not exceeding ½ in., but usually very much smaller, and which are automatically cleaned above the water line. The object of these fine screens is to remove to a certain extent the finer particles of matter, which, if allowed to remain in the sewage liquor, would otherwise be apt to use up rapidly the dissolved oxygen of the stream into which they are discharged, and their use is only recommended when the screened sewage is passed into a comparatively large body of water well supplied with oxygen. Many of the fine screens and the cleaning devices therefore are very elaborate, and the openings in the screens very small; in one screen, for example, they are only 2 mm. wide by 30 mm. long. The use of fine screens has been advised in several cases lately, *viz.*, Jamaica Bay, New York, Cleveland and many other places where it may be desirable to avoid accumulations of sludge or where the body of water into which the sewage liquor is discharged is large enough to deal with the dissolved impurities and finer suspended matter without offence.

There would seem to be an opening for fine screening under certain conditions in this country, as in the case of large rivers, where the volume and velocity are such as to admit of the discharge of fine suspended matter without injury; it would also appear to be adapted to seaside resorts where bathing is carried on, and where the presence of floating solids would be extremely objectionable. In any case, if fine screening is to be effective, it is essential that the sewage shall be as fresh as possible, and it must be fully recognized that the brunt of the purification will be thrown upon the body of water receiving the screened sewage, while turbidity and putrescibility will be but little affected; moerover, the efficiency of the screening will probably vary seasonably in the case of an extensive sewerage system, according to the temperature. In the case of a very large screening plant abroad, the seasonal percentage removal of solids was as follows: Spring, 18.7 per cent.; summer, 17.3 per cent.; autumn, 27.6 per cent.; winter, 48.3 per cent.

Concerning the removal of solids by gravity. Scant information is available about detritus tanks, both as regards most suitable design and also with reference to means of cleaning them, most designs having a good deal to be desired in this respect. Theoretically, the velocity through these tanks should be such as to permit settlement of the heavy mineral matter, while the lighter organic and mineral matter is carried forward; sewage flows, however, vary very considerably even in dry weather, and it therefore follows that, given a certain optimum rate of "flow through" for a particular sewage, there must of necessity be times, even in dry weather, when the rate of flow through may be either in excess of or below this optimum rate. With small or medium-sized works, by sacrificing a certain amount of fall, these variations could be controlled by a movable weir, enabling the capacity of the tank to be varied at will, and, as a sequence, the rate of flow through. In times of storm a duplicate tank would usually need to be brought into use, and detritus tanks should never be constructed in fewer than two units.

In the case of large treatment works it is advantageous to have ample tank capacity, subdivided into several units, which can be drawn upon as desired. Particular stress should be laid upon so designing detritus tanks as to ensure ample facilities for frequent and thorough cleansing; if drawing down the top water and removing the contents of detritus tanks is not rendered reasonably easy of accomplishment, and a filthy hand ladle process substituted, trouble will follow.

It is during the preliminary stages of sewage treatment that recovery of grease from ordinary domestic sewage appears feasible. Various processes have been placed on the market for the extraction of fatty substance from sewage sludge, but, so far as I am aware, few serious attempts have been made in this country to recover grease from the scum on sewage as it arrives at the works. It is not a question of whether, as frequently stated, recovery of grease is "commercially practicable"; the point is that sewage and sludge from which the bulk of the grease has been removed are rendered far easier of treatment, and better results are consequently obtained at less cost than would otherwise be the case. If something is obtained for the grease, so much the better. Grease renders sewage sludge very reluctant to part with its moisture; when the sludge is used as a manure it hinders sowing and subsequent decomposition; further, when grease reaches land, contact beds or percolating filters, it clogs up the pores of the soil, contact or filtering medium. Much has been said and written about the value of glycerine wasted in fats, but it must be remembered that if the fat is to be utilized for glycerine recovery, acid treatment is inadmissible, an alkali, such as caustic soda, being necessitated.

With reference to continuous flow settlement and precipitation tanks generally, there is a wide field of investigation open, especially in the direction of securing uniform rates of "flow through," and also in working out some means by which the efficiency of tanks can be more accurately determined. The method commonly in use, of expressing efficiency by percentage removal, is open to objection; it is the actual condition of the finished tank liquor which is the real criterion. Particular attention should be focussed upon the vital necessity for handling sludge as little as possible—any saving in this direction saves money—and also on the means to be adopted for drawing off the sludge from the tanks with a minimum of top water, and this can rarely be satisfactorily done without proper "draw-offs" discharging to a line of pipes distinct from the sludge pipes. Unless the sludging arrangements are good, the tanks will be run for two long periods, and it may be observed that unless continuous flow settlement tanks are frequently cleaned out, fifteen hours' flow through is, in most cases, too long, and partial septic action is almost certain to arise in hot weather.

It is quite possible for a portion of the sewage in a continuous flow settling tank to be septic, while the bulk of the liquid is fresh, and sometimes nuisance from smell arises from this cause, the sludge and overlying stratum of liquor becoming quite septic, and stinking when removed from a tank.

In any experimental work connected with settling tanks it is well to bear in mind the fact that the temperature of the liquid plays a considerable part, especially as regards the finer particles. For example, with a temperature of 74 deg. Fahr. it has been found that a fine particle will settle twice as fast as with a temperature of 32 deg. Fahr. Another point of importance is that with most sewages the lighter and more putrescible suspended solids are apt to be carried some distance down the ordinary rectangular tank before settling—*i.e.*, to a position where means for frequently drawing off these fine solids is rarely present.

Closely connected with tankage of sewage is the use of precipitants. One of the results of the war has been to restrict the use of certain precipitants involving the use of sulphuric acid, such as abumino-ferric—made by treating bauxite with sulphuric acid. In place of this precipitant, and also in lieu of sulphuric acid, what is known as "nitre-cake" (acid sulphate of sodium) has been somewhat largely used, this by-product resulting from the manufacture of nitric acid. Unfortunately, nitre-cake is a heavy and bulky precipitant, and its application to sewage liquors by no means so easy as alumino-ferric, although for certain purposes, where large quantities are not required, it can be obtained in powder form.

The day of precipitants is by no means over; they will probably be employed more frequently in the future, especially in cases where the effective removal of the finer putrescible solids is called for, and also where trade wastes are to be considered, either separately or in conjunction with sewage.

There is little doubt that, given efficient organization, sewage sludge could have been used for agricultural purposes far more freely than hitherto, even admitting that the percentage of actual manurial constituents in it is generally low judged by chemical analysis, and that it usually contains more or less grease, which makes it difficult to manipulate. It is quite possible that in the near future there may be a considerably increased demand for sewage sludge by farmers, and as the price of nitrogen increases, sewage sludge will probably become more valuable. In the case of a large sewage farm which I visited somewhat recently large quantities of air-dried sludge have been disposed of to farmers for years past at 3s. per load.

It is very usual to arrive at the value of sewage sludge by comparing it with sulphate of ammonia as a standard. The nitrogen in sulphate of ammonia, however, is in a readily available form, and its effects are practically limited to the year of application. The nitrogen in ordinary sludge sewage, on the other hand, is not as a rule readily yielded up to plant life, and in assessing the value of a manure, ease of decomposition is the chief point to be considered. There is nitrogen, for example, in leather, but it is only rendered available very slowly under natural conditions. The stimulating effects of an artificial manure are admittedly evanescent, and it possesses no "staple," whereas with sewage sludge the manurial effect is spread over a considerable period, while its cheapness renders possible the application of heavy dressings in order to compensate for comparatively low fertilizing value. I would direct the attention of all interested in sewage sludge to an order issued last October by the Ministry of Munitions concerning compound fertilizers and regulating the sale of these on a new basis. This should have the effect of stimulating the use of ordinary air-dried sewage sludge in compound manures, the unit rate for nitrogen in sewage sludge being 7s. 6d., as against 17s. 6d. in the case of nitrogen derived from sulphate of ammonia, nitrate of soda, etc. The word "unit" is defined to mean 1 per cent. by weight in one ton of compound fertilizer. It follows that a sewage sludge containing one unit of nitrogen would have a value of 7s. 6d., and in most cases it would be easy to air-dry sludge down to a point where the contained nitrogen reached 2 per cent.

With regard to the use of wet sludge, I may refer to the plan adopted at the Wolverhampton sewage farm by William Clifford, A.M.Inst.C.E., the engineer and manager. The method has now been in use for some four years, during the months of September to April. Briefly, the wet precipitation sludge is forced by compressed air through 4-in. diameter light iron pipes, provided with flexible joints, and irrigated upon farm lands in the neighborhood of the works. The farmer provides the horses and ridge plough, and the sewage works staff the labor. A nominal charge of 10s. per acre is made, but instead of payment in money an equivalent in horse hire is taken. On grass land the liquid sludge is brushed over the surface with bass brooms. From May to August the sludge is irrigated over some 6 to 7 acres of land adjoining the works. After each dressing a cultivator is passed over the land, and deodorization is found to be satisfactory. A good dressing serves for a root crop and a straw crop, or, alternatively, two grass crops. Given sufficient storage, it is considered that it would be practicable to dispose of the whole year's make of sludge in eight months.

LETTER TO THE EDITOR

Garbage and Refuse Disposal

Sir,—We read with much interest the article by Dr. Rudolph Hering in *The Canadian Engineer* of March 14th, and only wish the same article would be reprinted in all the engineering magazines throughout the whole of this continent. The writer has been interested in the question of incineration for many years, in Europe and America, and has developed a plant with many of the features about which Dr. Hering writes.

If only it were possible to get all municipalities to study every word in that article, much of the money now spent on experimenting would be used in erecting plants which would destroy their refuse and garbage, and give them a clean town or city.

Then the question of cost arises. We find that some of our competitors are erecting plants where the cost for burning is as high as $1.50 per ton of garbage burned, while we have plants that are doing it for as low as 28 cents. This, of course, is low, but it can be done, particularly if there be sufficient garbage and refuse to keep the plant in continual operation. This is, however, impossible in any of the towns or cities where we have built incinerator plants.

We have just completed a five-cell plant at Windsor, Ont. This plant is burning all the city's garbage, etc., without the use of any fuel, but, just as Dr. Hering says, the fireman needs to be intelligent, for they will use up any amount of fuel if one allows them to have it. We put in an oil burner to each cell, for use only when starting the fires or when the garbage is exceptionally wet, but most of the firemen seem to delight in seeing the oil burned, and it takes a little time to teach them that they do not need it. We have succeeded in making our plants destroy all ordinary garbage and refuse without using any fuel except that found in the garbage itself.

J. G. PICKARD,
Canadian Incinerator Co., Limited.

Windsor, Ont., March 16th, 1918.

BOARD OF ENERGY COMMISSIONERS RECOMMENDED

A FEW weeks ago, before the Ottawa Branch of the Canadian Society of Civil Engineers, John Blizard, B.Sc., read a paper on the "Availability of Energy for Heat and Power," which was published in full in *The Canadian Engineer* for March 7th.

At that same meeting Edgar Stanfield, M.Sc., chief engineering chemist, Mines Branch, was invited to be present and spoke as follows:—

I have greatly valued the privilege of attending this meeting and listening to Mr. Blizard's excellent paper, the more so because for the past eleven years I have been closely associated with him in work on fuel problems.

There are two points to which I desire to call attention. The first is that Mr. Blizard has made it evident that the question of how best to utilize our sources of energy involves both engineering and chemical problems. There was a tendency to relegate the chemist to the attic, as it were, and to submit to him only specific questions; this is, fortunately, now passing, or passed. We must realize that only by full co-operation between engineer and chemist can we make satisfactory progress towards our goal.

A full treatment of the fuel problem cannot neglect the chemical possibilities of fuels. It is needless to enumerate the chemical compounds, dyes, fertilizers, antiseptics, etc., obtained from coal; their great number and their importance are too well known. They are all derived, as was stated in the paper, from the primary products of the carbonization or coking of coal. The coking of coal and the exploitation of its by-products constitutes a very large industry, notably in Germany, but also in England and elsewhere. The paper points out some of the limitations of this method of utilizing fuels. In Canada our difficulties in this respect, as in others, are greatly increased by the distance between centres of population and the geographic distribution of our fuels. Nevertheless, I am more optimistic than Mr. Blizard as to the future of the carbonization industry. It does not appear to me impossible that even in Ottawa we may have in the not very distant future a large coke oven plant which will operate on water-borne soft coal from Nova Scotia, coking it in ovens rather than in retorts on account of the economies of the larger scale process, and which will distribute gas and coke for domestic and factory use throughout the cities of Ottawa and Hull.

Mr. Blizard referred to oven coke as "metallurgical coke," and described it as too hard for convenient domestic use; such coke is made by what is called high temperature carbonization. Low temperature carbonization gives a softer coke and has many apparent advantages. Its commercial development with respect to bituminous coal so far, however, has been very disappointing, although I still hope for a future for the method.

Carbonization is not confined to bituminous coal. The commercial development of low-grade lignite will probably involve low temperature carbonization. Some of us have been engaged for the past year in studying in the laboratory the possibilities of this process, and, as has been stated in the daily papers, there is a project under consideration for the establishment of a commercial carbonizing and briquetting plant in the West. I am of the opinion, moreover, that the carbonization of peat may prove a commercial possibility. The carbonizaton of wood to form charcoal, wood alcohol, acetic acid, etc., is already a well-established industry. In every case carbonization gives solid, liquid and gaseous products with great economic possibilities. The solid products of the lower grade fuels—lignite, peat and wood—have comparatively high calorific value, and can, therefore, stand transportation charges to far greater distances than can the original fuel.

The second point to which I desire to call attention is the way in which private individuals and corporations wastefully exploit our resources of fuel for their own immediate gain.

Coal is wasted in many ways in the winning, and Mr. Dick has stated that the percentage of available coal brought to the surface from our mines is often very low. Thus, where a thick and a thin seam occur together, quick profits can be made by working the thick seam only, but the thin seam is lost to us, probably for ever. Is this right?

Under present conditions, in some districts remote from centres of population, immediate profits might be made by extracting gasoline from natural gas and allowing the gas to go to waste for lack of a convenient market. Can this be permitted?

Fuels are wasted in utilization, as Mr. Blizard has shown. Our railways burn nine million tons of coal a year with an efficiency of only three per cent. Out-of-date and inefficient power plants are wasting our fuel resources, and the wasteful use as well as the wrongful use of power on all sides add to this orgy of extravagance. These methods may give immediate dividends to individuals, but we must consider the present and the future welfare of the whole country. Can we afford to let these methods continue?

Again and again arise the questions: Is it right wastefully to exploit our resources for immediate gain? Can we afford to allow this waste to continue?

Mr. Blizard's paper not only calls attention to these points, but is also suggestive as to methods of remedy. May I recommend the following for consideration:—

That a Dominion Board of Energy Commissioners be established, somewhat on the lines of the Board of Railway Commissioners, and that this board be given wide powers.

That the board consist of mechanical engineers, electrical engineers and chemists; the best men available in their respective spheres, having not only high scientific and technical ability, but imagination.

That the board be given investigative, advisory and restrictive powers—investigative power to carry out such laboratory and large-scale investigations as are necessary for the efficient utilization of our resources; the scope of the investigations to include the winning and marketing of fuels and their by-products, as well as the development and employment of power and heat; advisory power to furnish the best advice and most up-to-date information, including recommendations as to new developments, improvements of old plants, consolidation of power plants, and the co-operative establishment of allied industries; restrictive power to prohibit the inception of needlessly wasteful schemes, and to compel the improvement within a term of years, where such improvement can be shown to be commercially practicable, of all established, needlessly wasteful processes.

The recommendation as outlined above was considered by the Ottawa Branch of the society and later submitted to the council of the society at Montreal.

Col. R. W. Leonard, M.Can.Soc.C.E., will address the Ottawa branch of the Canadian Society of Civil Engineers this evening on "The Manufacture of Nicu Steel."

TRAFFIC REGULATIONS IN RELATION TO ROAD CONSTRUCTION AND MAINTENANCE*

By W. A. McLean, C.E.
Deputy Minister of Highways, Ontario.

TRAFFIC regulation in its relation to road construction and maintenance is a matter in which highway engineers and those held responsible for road conditions have been unduly patient. Traffic regulation there is, it is true, but for the greater part with a view only to questions of public safety and convenience.

The durability of a road is, by the average citizen, regarded as independent of traffic; and it seldom occurs to him that the use and the abuse of roads are closely related. The road, it is assumed, must be able to sustain any form of traffic and any load to which it can be subjected, and if the road fails, or shows sign of wear, the fault is that of the builder, regardless of impossible and extraordinary traffic conditions to which the road may have been subjected, and for which it was not, perhaps could not, have been designed and built.

When traffic regulation in relation to road construction is mentioned, we are apt to be told that restriction would tend to retard the good roads movement; that unless "good roads" can carry any load at any speed, we lose a chief argument in their favor, *viz.*, greater speed, heavier loads.

With unlimited funds the engineer can build roads which will sustain unrestricted traffic. But is the engineer justified in asking the public to pay for such construction? Will the public continue to pay for such roads, even if they are asked to do so? Or is it preferable that the traffic should be restricted within reasonable limits to effect a great saving in cost? Consideration will indicate that the latter is a sound, economic course. And it is, therefore, desirable that the public should be informed in the matter; that reasonable traffic standards be fixed and enforced, and that roads be then designed for these conditions.

It should be emphasized that reasonable standards should be fixed. Undue limitation should not be placed on the weight and speed of vehicles, otherwise the value of the common road and vehicles in transportation, and their future development, will be retarded. The question largely resolves itself, therefore, into the problem: What are the limits which should be adopted? Can these limits be varied for different roads? Or for different seasons of the year? Or in minor details which may affect construction?

It is desirable that the engineer should know, approximately, the number of vehicles for which a road is to be built. In this there is necessarily much uncertainty, as traffic tributary to a road is subject to many vagaries and much fluctuation. Assumptions must be made in this respect. But it is enough that assumptions should be made where uncertainty is unavoidable. Traffic regulation will fix some factors which can reasonably be definite.

Weight of Vehicles

The maximum weight of vehicles (apart from the well-recognized influence on bridges) largely determines the depth of foundation necessary on a given road, the depth of foundation varying also according to the nature of the subsoil, and particularly in northern climates, the season of the year during which heavy vehicles may use the road. The constant passing of many light vehicles will, it is true, influence the foundation, and to meet this condition, a certain "mass" is required; but a very few heavy vehicles may shatter an insufficient foundation and thus destroy the entire construction. It is material, therefore, that the engineer should know whether the maximum load is to be six tons, ten tons, twelve tons, fifteen tons, twenty tons; particularly the maximum load concentrated on one axle or one wheel, and also the width of tire on which the maximum load is concentrated.

Motor and steam trucks are coming into extensive use on the country highways. Commonly a motor truck, itself weighing five tons, can carry a load of seven tons, making twelve tons in all. Two-thirds, or eight tons, is on the rear axle, one-half of that load, or four tons, is on each rear wheel. The disruptive effect of this load on roads of light construction is very great, particularly in wet seasons.

Steam trucks, with steel tires, in some cases corrugated, are now in occasional use. As an instance, a five-ton steam wagon in running order with fuel and water, weighs about six tons ten cwt., with about two tons fifteen cwt., on the front axle and three tons fifteen cwt. on the back axle. Practically all the load would come on the back wheels so that when loaded with five tons, the actual weight on the back axles would be eight tons fifteen cwt., or over four tons seven cwt. on each rear wheel. Motor trucks carrying fifteen tons and weighing in all about thirty tons, are being manufactured.

Self-propelled gasoline motor and steam trucks, in addition to their heavy concentrated load, have the further disadvantage of exerting a strong driving force (referred to more fully in discussing motor car speed) so that their use demands not only a heavy and expensive foundation, but an especially durable surface as well. Legislation limiting extraordinary traffic of this description would appear justifiable, in order that a large increase in the cost of roads may not be necessary to serve the requirements of a few vehicles. Such limitation at the present time would forestall the introduction of unnecessarily heavy vehicles and would avoid cases of individual hardship. Width of tire alone will not solve the difficulty, as, owing to the necessary camber of the road surface, excessive width places the load on the edge of the tire. Should investigation justify it, a less weight would be most desirable in the interest of road maintenance.

The following schedule is drawn up with a view to the traffic law of Ontario, which permits a maximum load of twelve tons, or four and one-half tons on one wheel; and a maximum pressure of six hundred and fifty pounds per inch in width of tire. The general assumptions are, that two-thirds of the weight of the vehicle and its load will be carried on the rear axles; that wheel pressure is transmitted downward at an angle of thirty degrees from the vertical; that the various types of subsoil will safely carry the pressure indicated at the head of each column; that the road crust is solely of broken stone or macadam construction.

From the schedule it is evident that twelve tons is the maximum load which can be carried without producing an excessive tire pressure; that there is little difficulty in providing for a twelve-ton load on gravel, compact sand or firm clay; that clay only moderately dry requires a crust approximately ten inches in thickness; that twelve inches will take care of a six-ton load on wet clay, but that sixteen inches would be required for a load of twelve tons (a condition which could probably be taken care of by a Telford base and broken stone surface having a total depth of twelve inches). In the case of quicksand and wet, yielding soil, it is evident that special drainage

*Address to the American Road Builders' Association.

Table Showing Required Thickness of Road Crust to Transmit at an Angle of 30° from the Vertical Safe Bearing Pressures to Subgrades of Various Soils

650 pounds per inch width of tire up to 12-inch tire

				DEPTH OF STONE IN INCHES				
Weight on Vehicle, tons	Weight on Rear Wheel, tons	Width of Tire, inches	Weight per inch width of Tire, pounds	Gravel, 8 tons per square foot	Compact Sand or firm Clay, 4 tons per square foot	Clay moderately dry, 2 tons per square foot	Wet Clay, 1 ton per square foot	Quick Sand or Wet Yielding Soil, ½ ton per square foot
3	1	3.07	650	2.33	3.74	5.98	9.05	13.40
6	2	6.15	650	2.63	4.87	7.92	12.25	18.30
9	3	9.21	650	3.16	5.65	9.20	14.40	21.80
12	4	12.00	666	3.46	6.10	9.60	16.20	24.80
15	5	12.00	833	4.20	7.26	12.00	18.60	28.20
18	6	12.00	1,000	4.90	8.26	13.50	20.82	31.50
21	7	12.00	1,166	5.48	9.20	14.65	22.50	34.60

or other special construction is necessary to meet the needs of any but a light load.

As clay is a soil which has very largely to be considered, its drainage and climatic conditions are evidently important factors, as indicated by the difference in depth of crust required by a moderately dry clay and one that is wet.

Military experience will probably indicate the most desirable type and weight of truck for future industrial purposes. The great majority of trucks now used by the French armies weigh three and one-half tons empty and seven to eight tons loaded. This standard, applied to road construction generally would effect a great saving in cost as compared with the maximum of fifteen or twenty tons which unrestricted loading will involve. If military preparedness demands provision for heavy artillery loadings of twenty tons (and the tendency is still upward) a more moderate standard should be enforced with respect to the great network of purely agricultural and industrial roads which cannot be so built without imposing an unnecessary financial burden.

Climatic Regulation

The State of Michigan has adopted a very useful regulation which provides that "it shall be unlawful to move any traction engine or similar heavy machinery over the public highways, by its own power or otherwise, during the months of March, April and May, or at any other time, if by reason of the thawing of frost, or rains, or any other cause, the roads are in soft condition rendering them unfit for the passage over them of such heavy machinery without damage to the highways, or if the engines are equipped with lugs which seriously damage the highways, except by written permission from the commissioners having jurisdiction over said highway or highways." With respect to tires, the Michigan law also provides that: "Whenever by reason of the thawing of frost, or rains the roads are in soft condition, the maximum carrying capacity of tires on all vehicles shall be limited to one-half the carrying capacity of tires as provided in this Act."

Width of Tires

Having determined the foundation which a given subsoil and load of vehicle will require, the influence of traffic on the surface remains to be considered.

The crushing effect of steel tires is an important factor, and is one of the features which, in the days of horse-drawn traffic only, was covered by "wide-tire" laws. Wide-tire laws are still necessary, although their relative importance has diminished through the growing preponderance of rubber-tired vehicles. Local considerations will necessarily control to a certain extent, but the crushing strength of local material available will necessarily be a factor. In a district where trap rock is freely available for the road surface, the concentrated loads may be greater than where soft limestone is the only material obtainable.

In Ontario a maximum load of 650 pounds per inch in width of the tire is permitted. In Great Britain, the width of hard-tired trucks may vary, according to axle weight and diameter of wheel, from five inches to fifteen inches. In Michigan, a carefully regulated schedule of widths has recently been imposed.

Extraordinary Traffic

The traffic law of Great Britain recognizes the relationship between traffic and liability for maintenance, in a statute respecting extraordinary traffic, which proceeds in part as follows:—

"Where, by a certificate of their surveyor, it appears to the authority which is liable or has undertaken to repair any highway, whether a main road or not, that having regard to the average expense of repairing highways in the neighborhood, extraordinary expenses have been incurred by such authority in repairing such highway by reason of the damage caused by excessive weight passing along the same, or extraordinary traffic thereon, such authority may recover from any person by or in consequence of whose order such weight or traffic has been conducted, the amount of such expenses as may be proved to the satisfaction of the court having recognizance of the case to have been incurred by such authority by reason of the damage arising from such weight or traffic as aforesaid.

"Provided that any person against whom expenses are or may be recoverable under this section, may enter into an agreement with such authority as is mentioned in this section, for the payment to them of a compensation in respect of such weight or traffic, and thereupon the persons so paying the same shall not be subject to any proceedings under this section."

Speed Regulation

In the case of rubber-tired vehicles, speed is an important factor. It is the general experience that light motor vehicles travelling at a speed of 18 to 20 miles an hour are not difficult to cope with. That much injury to macadam road surfaces results from heavy touring cars travelling at speeds of 40 and 50 miles an hour is common knowledge to the highway engineer; where it exists to any great extent, demanding the proportionate cost of bituminous treatment, or the selection of a strongly resistent paving material.

The propelling power of a horse-drawn vehicle is communicated to the road through the feet of the horses. Speed is limited and makes little difference. The abrading effect of the steel tires comes solely from a downward pressure varying with the weight of load, diameter and width of tire. Self-propelled vehicles, on the other hand, communicate their driving force to the road at the rim of the wheel. While the downward pressure due to weight of load does little injury, the driving force is very great. It is nearly horizontal, tending to tear away the surface of the road, throwing out the binding material and loosening stones. This shearing force increases with the speed, not in direct proportion, but probably in proportion to the square of the speed. Thus, taking ten miles as a unit of speed and comparing with speeds of twenty, thirty and forty miles, the shearing force is not merely twice as great at twenty, three times at thirty and four times at forty, but instead is four times as great at twenty as at ten miles, nine times as great at thirty and sixteen times as great at forty miles. At fifty miles an hour, the shearing force on this basis would be twenty-five times as great as at ten miles.

Excessive speed is thus exceedingly destructive to improved roads. Motor cars of moderate weight travelling at a speed of twenty miles an hour, do comparatively little injury to a well-built road. Heavy cars travelling at a rate of forty or fifty miles an hour do excessive injury which can be provided for only by expensive types of construction. While these types can be adopted for main highways, as in the case of foundations, the greater network of minor roads require speed limitation, in order that heavy construction and maintenance costs may not be unnecessarily imposed. This is the more important at the present stage of road development on this continent, when a large mileage must be maintained at low cost while main routes are in course of construction.

Relation of Highway Department

In view of the close relationship between traffic regulation and the design of roads, their cost of construction and maintenance, it is desirable that governmental highway departments and motor vehicle registration and control should be under the one management. Responsibility is more definitely fixed, as a highway department is more likely to secure a proper observance of traffic laws to the advantage of the roads and those who pay for them, the factors to be met in construction and maintenance are under more definite observation and control, the development of traffic laws is under more logical guidance, and payment of motor car fees is more agreeable to the car owner if he sees the money going directly to the department which builds and maintains roads. When this policy was adopted in Ontario, the schedule of fees was concurrently doubled with little complaint from our car owners. Ontario is the only province of Canada in which the highway department administers traffic laws and collects revenue. In the United States, Massachusetts, Pennsylvania, Rhode Island, Arkansas, Idaho and Oklahoma appear to be the States in which this policy is followed.

Conclusion

Highways and the vehicles using them should be considered together. This is as logical as that railroads and rolling stock should be so related.

A rule for definitely fixing standards of loads, widths of vehicles, widths of tires and speeds of self-propelled vehicles, is necessary to the intelligent design of roads. The control of traffic by the department responsible for road construction and maintenance is of advantage.

THAWING WATER PIPES BY ELECTRICITY*

By H. D. Rothwell

Hydro-Electric Power Commission, North Bay, Ont.

THE difficulties which present themselves in the operation of waterworks in the northern climates are many, and not the least of these is the thawing of frozen service pipes.

These are due to the prolonged cold weather, or because there is insufficient earth covering to protect the pipes. In many cases even the mains themselves will freeze, where the flow of water is inclined to be sluggish, thereby rendering part of the system ineffective for domestic use and crippling it entirely in case of fire.

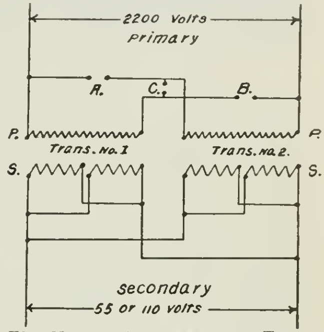


Fig. No. 1.—Arrangement of Transformers to Obtain 55 Volts

The thawing of frozen water pipes by means of an electric current is quite simple, and undoubtedly the most effective of any of the methods in use to-day. Pipes up to three inches in diameter may be thawed in a few minutes by passing a heavy electric current at low voltage through the pipes. In most cases, pipes will be frozen only for a few feet, where they are exposed the most, and in such cases, the time required is usually measured in seconds, and even where pipes are frozen for fifteen or twenty feet, the time required is not usually over eight minutes, and in practically no cases would be sufficiently long to affect the municipality's twenty - minute sustained peak. From the records of over 75 conservative cases where service pipes were frozen, the maximum time required to thaw any one service was not over five minutes, and the majority were not over thirty seconds. One case was noted, however, where the current was left on for twenty minutes, and, on further examination, it was found that the valve on the street was closed. Thawing operations are not usually carried on past the point where the water begins to flow, as it is found cheaper to let the flowing water thaw the core of ice which remains in the pipe.

Fig. No. 2—Connecting the Primary Leads to the 2,200-Volt Circuit

The apparatus required for thawing water pipes consists of two 15 k.v.a. (2,200-volt, 110-volt) single-phase transformers, with the primary windings arranged in such manner that they

*From the Bulletin of the Hydro-Electric Power Commission of Ontario.

Fig. No. 3.—Thawing Outfit, Showing Secondary Reels, Etc.

may be connected in series or parallel. This is accomplished by three primary cut-outs, as shown in Fig. No. 1. By this arrangement, if the two fuse plugs are inserted in position "A" and "B," the windings will be in parallel, or if one fuse plug is inserted in position "C," the windings will be in series. Fuse plugs are used instead of switches, owing to the fact that a short circuit might be caused by closing the wrong combination of switches.

The secondary windings of the transformers are connected permanently in parallel and by this arrangement it is possible to get 55 volts or 110 volts, depending upon the arrangement of the primary windings—whether they are connected in series or in parallel.

The transformers, which are mounted on the centre of a sleigh, are clamped together by four cross-arms and six through bolts. The cross-arms serve as a support for the cut-out and also an ammeter, which is connected in the primary side, to indicate the current taken.

Four reels of wire are carried as a part of the outfit. The two mounted on the rear of the sleigh are No. 6, B. and S. gauge, stranded, double-braid, rubber-covered, and are used for making connections to the 2,200-volt primary.

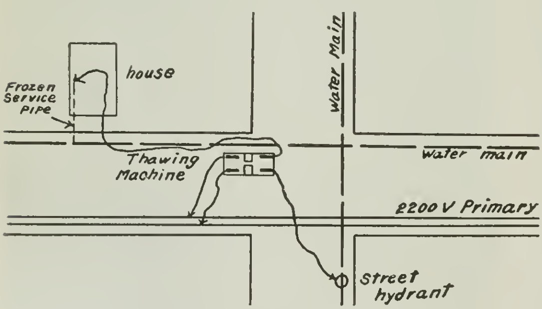


Fig. No. 4.—Thawing Frozen Service Pipe

The two forward reels are bare No. 210, extra flexible, copper cable. Primary reels carry about 800 feet on each, whereas the secondary reels contain about 250 feet on each.

The ends of the wires nearest the centre of the reels are brought out through a hole made in the side, and a suitable connector is soldered on, which facilitates the making of connections to both the primary and the secondary transformers, after sufficient wire has been payed out.

The usual method of thawing an ordinary house service is to connect one of the secondary cables to the nearest street hydrant and to attach the other to the cold-water tap on the service to be thawed. Having already connected the primary leads to the nearest 2,200-volt circuit, all that remains to be done is to insert the fuse plug in position "C", and the thawing will commence immediately. By watching the ammeter, the operator can usually tell if sufficient current is flowing to complete the thawing. In a few cases, were the street hydrant a considerable distance away, it would be necessary to use 110 volts, but such instances would not be many on the ordinary waterworks system.

CO-OPERATION IN ROAD BUILDING*

By John G. D. Mack
Chief Engineer, State of Wisconsin.

But a few years have passed since it was difficult to convince more than a small fraction of the people of the necessity of good highways and of the requisite expenditure of money for this purpose.

Now, however, the demand for good roads is greater than the capacity of the road builders to supply the immediate wants of the public. The good roads movement seems firmly established, so that plans may be made for years ahead, looking toward the final and complete development and not merely a season's patchwork, with the patches often widely scattered.

Continuous and permanent results can be obtained only by complete co-operation on the part of every organization and individual interested in better highways.

A portion of a highway is no more a local affair only than is a part of a railway, telephone or telegraph system or a part of the postal service to be so considered.

This growth in highway interest is shown by the change from a town matter to county, then to state, and now to federal interest in the projects. The co-operation has spread to be nation-wide.

Everyone cannot live alongside a main trunk railway, nor can everyone live adjacent to a trunk highway.

It is co-operation in the road work which in time will give those who live at a distance from the trunk highway a good route to the trunk line, just as the branch railway carries us and our freight to the main line for the long haul.

To carry this work to its best development, the public must be kept in touch with the plans so that everyone may be able to see and understand just what is being done, and what connection the roads in front of his place or in the next neighborhood has with the general scheme.

Many unnecessary and unjust criticisms are made, not only of highway, but of other construction projects, because the complete plan is not understood.

This is the co-operation, based on the information of the public, which we must have. Such information is given at public meetings, by individual effort, in magazines and in newspapers.

In addition to these most excellent methods, I wish to note another possibility of great promise—the schools.

Make opportunities, in which I am sure the teachers will aid, to give talks on your section in the schools of

*Paper read before the Wisconsin Highway Commission.

your district. Illustrate these talks with maps and describe why the road is located as shown, how it is to be constructed, how it is to be financed, its cost, its relation to other parts of the system, and other points of general interest.

There is no better lesson in local geography, with some economics, arithmetic and other subjects thrown in. Furthermore, anyone who has children in school knows that the points given in school rather lead the home conversation. One other point we sometimes overlook, and a very important one it is in this connection, is that before we "grown-ups" realize it, the present-day school children are also grown up, and we should therefore give them an early and correct start on the principles of good road development.

All that we of this age have, and all that we are, is the result of co-operation and the division of labor among specialists.

In the museum of the State Historical Society of Wisconsin is an exhibit which never fails to stop me for a moment at least, although I have seen it a great many times, as it illustrates this point so well. It is a model of a Wisconsin pioneer's log cabin home, which was made under the specification that the only tool available in building the original was an axe.

The co-operation and co-ordination of innumerable specialized industries are joined in the building of even a small residence to-day, and so it is with every work which we undertake and with everything which surrounds us.

To illustrate: Just think where that simple axe of the pioneer came from, and of the co-ordinated mining, metallurgical and transportation industries which made it possible.

It is the same with good highway progress. The work must continue to be planned and the construction carried out by those who are specially qualified by study and experience for the tasks.

In addition to this, we must never lose a single opportunity in any direction in which it may appear to work for complete co-operation.

W. J. FRANCIS HEADS MONTREAL BRANCH

Walter J. Francis, consulting engineer, was elected last Thursday as the chairman of the newly formed Montreal Branch of the Canadian Society of Civil Engineers, Arthur Surveyer, consulting engineer, was elected vice-chairman, and Frederick B. Brown, a partner in the firm of Walter J. Francis & Co., was elected secretary-treasurer. An executive committee was elected as follows:—

F. P. Shearwood, designing engineer of the Dominion Bridge Co.; W. Chase Thomson, consulting engineer; H. G. Hunter, resident engineer for the New York Continental Jewell Filtration Co.; L. G. Papineau, consulting engineer; O. O. Lefebvre, chief engineer, Quebec Streams Commission; and K. B. Thornton, chief engineer, Montreal Public Service Corporation.

The meeting held last Thursday evening in Montreal was the last meeting there of the parent society under the old by-laws. All future Montreal meetings will be Montreal Branch meetings—not meetings of the society as a whole—excepting when general professional meetings or annual meetings are held there, as provided for in the new by-laws recently adopted by the society. Brief addresses were delivered by H. H. Vaughan, the president, and by Chairman-elect Francis, and Commander J. W. Skentelbury, R.N., described the work of the Great Silent Fleet.

POPULAR OBJECTIONS TO WATER METERING AND HOW TO OVERCOME THEM*

THE opposition to metering is due largely to prejudice and to a misapprehension as to the results which follow the installation of meters. There is a generally prevalent belief that meters are intended to restrict the "use" of water and that, unless the consumer cuts down the quantity of water which he requires or is accustomed to use, his water bills will be increased. The problem, therefore, is to overcome this prejudice and misapprehension by demonstrating that meters do not restrict the "use" of water; that they produce results by preventing waste and leakage; and that they result in an equitable apportionment of water charges, and in the reduction rather than in the increase of bills in the vast majority of cases. If consumers and owners can be convinced of these facts, opposition to metering will disappear. The same arguments that are advanced against meters to-day have been used for years not only in Chicago but in practically every other city where metering has been proposed. Yet wherever it has been introduced experience has demonstrated that there was and is no basis for the objections raised.

Metering is not proposed as a means of restricting the "use" of water. "Use," we repeat, is meant to include every legitimate use to which water can be put for domestic, industrial, and municipal purposes, including water for sprinkling streets and lawns, extinguishing fires, flushing sewers, and every other purpose for which water is necessary or has any real value. The abundant use of water should be encouraged and every inducement should be held out, particularly to domestic consumers to insure their using all the water which can possibly be of value in improving health and sanitary conditions. To this end, rates should be fixed so as to guarantee every consumer an ample supply at a reasonable price which he should be required to pay even though he fail to use his full allowance. A minimum charge of this kind would remove any inducement to "skimp" or save on water at the expense of health or comfort and, as hereafter pointed out, would serve other important purposes.

One reason why metering is advocated is because it is the most effective means for insuring an abundant supply of water under sufficient pressure to enable all consumers, including those living in sections remote from pumping stations and upon the upper floors of apartment buildings, to obtain promptly and at all times the water which they require and are entitled to for their legitimate uses. This would be accomplished by curtailing waste and leakage and not by restricting "use." Such a condition has never existed in Chicago and in the opinion of the Bureau never will be brought about until metering is introduced on a comprehensive scale.

Meters are not intended to operate as a restriction upon the "use" of water and they do not in fact produce that result. This is well illustrated by the situation in Cleveland, Ohio, and in Oak Park, Ill., both of which are under complete meter control. Both Cleveland and Oak Park charge on the basis of a certain rate per 1,000 gals. but fix a minimum charge which must be paid whether or not the quantity of water to which the consumer is entitled for that charge is used.

In Cleveland, the minimum charge applicable to the large majority of consumers is \$2.50 or \$5 a year, depending upon the size of the building, the number of fixtures,

*Abstracted from "The Water Works System of Chicago," a recent report by the Chicago Bureau of Public Efficiency.

etc. For these amounts consumers are entitled to 46,875 and 93,750 gallons, respectively. For the 6 months period ended September 30th, 1915, there were 27,374 consumers liable to pay at the $2.50 rate and 60,393 liable to pay at the $5 rate regardless of whether or not they used the full amount of water to which they were entitled under those rates. Of the 27,374 subject to the $2.50 rate, 18,141, or 66 per cent., used less water than they were entitled to and paid for; of the 60,393 subject to the $5 rate, 35,481, or 58 per cent., used less water than they were entitled to and paid for, and 12,814 used less than half that amount. These figures cover the summer period when the consumption was heaviest on account of the use of water for sprinkling purposes and on account of such use as may have been made of it for cooling purposes. During the winter period even a large number of consumers failed to use the amount to which they were entitled for the minimum charge. The Bureau does not mean to be understood as expressing any opinion as to the reasonableness of the charges here cited. The purpose in citing them is merely to show that when consumers are required to pay a relatively small minimum charge—one smaller than the flat rate charge made in thousands of cases in Chicago—they are unable to "use" all the water that such a minimum charge will buy.

In Oak Park the minimum charge is $7 per year, for which the consumer is entitled to 36,000 gallons. The accounts for a recent year show that of 4,546 residential consumers subject to this minimum charge 941, or 21 per cent., used less water than they were entitled to and paid for.

At the minimum rates above mentioned there could be no possible incentive for anyone to restrict his use of water, and certainly it is not to be inferred that the people of either Cleveland or Oak Park have lower standards of cleanliness than the people of other communities or that they require less water for their legitimate uses.

Metering produces results not by restricting usage, but by preventing waste and leakage. When a consumer knows that he will have to pay for the water that he wastes, he is careful to avoid wastage. He no longer installs fixtures of a cheap and wasteful type, such as hopper closets, or permits minor leaks, which can be readily repaired at trifling expense, to continue indefinitely; he protects his pipes from freezing so that there is no occasion to let the water run continuously during cold weather and he shuts off the hose when he is through using it for sprinkling purposes; he avoids leaving the faucet open when not using water; and in countless other ways is careful to prevent waste. With practically every other consumer exercising this care to eliminate waste, water can be furnished so cheaply that no one need think of restricting the amount which he can make any use of.

Keeping plumbing tight and shutting off the water when it is not in use are the important factors in effecting waste control, and there is nothing unfair or harsh in the suggestion that water users be required either to observe these precautions or to pay the penalty of their own shiftlessness and carelessness. Experience shows that about half the people who use water are not wasteful or shiftless. The exercise of reasonable care in matters related to the water supply, as in other things, becomes a habit with them and imposes no hardship. It is manifestly unfair, therefore, to permit the other half who are wasteful to saddle the expense of their carelessness and shiftlessness upon their more careful neighbors. If consumers insist upon wasting water, either wilfully or by permitting their plumbing to remain continuously out of repair or by installing cheap and wasteful fixtures, they should be required to pay for what they waste. Under metering they do pay for it. The result is that they soon find it profitable to stop the waste.

The problem growing out of the use of water for cooling purposes is not so easily disposed of, however, since there is considerable public sentiment against restricting the practice, which prevails largely in those sections of the city tenanted by families too poor to provide themselves with ice. Lake water is not really effective as a means of refrigeration, and from the standpoint of the city, its wasteful use for such purpose is expensive. Probably it would be cheaper for the city to furnish the poor with ice than to permit a continuance of the waste which at present exists in this connection. Assuming, however, that in the absence of some better arrangement these poor families can make some legitimate use of water for cooling purposes, it may be safely asserted that they now waste more than they use in the process. Only a moderate quantity is required. A wide-open faucet is no more effective than one permitting the continuous flow of a small stream. If proper care were taken to regulate the size of the stream, all the water which a family could use by letting it run continuously four months of the year would not cost to exceed $2. Moreover, in many cases the minimum charge which a consumer should be required to pay would entitle him to all the water used in this way, in addition to that used for other purposes. In such cases, of course, the use of water for cooling purposes would not impose any additional financial burden upon the user.

It is sometimes urged that the excessive amount of waste and leakage in Chicago tends to help in the matter of sanitation. This is due entirely to a misunderstanding of the facts. Waste reduction measures do not aim to curtail the abundance of water which is essential to cleanliness and proper sanitary conditions. Their purpose is to cut down the enormous quantity of water which runs away through sewers and the ground without serving any useful purpose whatever.

Another reason why meters are opposed is the belief that they operate to increase water bills. This belief prevails quite generally where meters have not been introduced. The consumer who pays his own bill feels that in order to avoid increased cost he will have to cut down the amount of water which he needs or has been accustomed to use. The landlord who pays the charges for the water used by his tenants fears that he will be robbed by the wastefulness of the latter, who will have no incentive to avoid waste. Each therefore is opposed to meters. Moreover, the landlord, in addition to exerting his own influence against them, by threats of increasing rents or otherwise, often persuades his tenant to oppose them. The opposition to meters accordingly becomes general. Opposition to metering on this ground is due entirely to misapprehension as to the effect of meters upon charges.

At the recent conference between members of the government and representatives of transportation companies and harbor commissions, it was suggested that the three necessary factors to increase overseas transportation are:— 1, Ships; 2, improved terminal facilities at the various Canadian ports; 3, better railway facilities for the delivery of goods at the ports.

The occupations of the 235 members composing the new House of Commons, according to figures compiled by W. F. O'Connor, general returning officer, are: Barristers, 73; notaries, 3; conveyancer, 1; physicians, 23; veterinaries, 2; dentist, 1; farmers, 39; rancher, 1; publishers and journalists, 11; educationalists, 2; manufacturers, 23; lumber operators, 7; contractors, 2; merchants, 22; brokers and agents, 17; plumber, 1; railway conductor, 1; land surveyor, 1; military officers, 4; **engineers, none.**

ARMSTRONG-WHITWORTH PLANT

WHEN the tentative program was prepared for the last annual meeting of the Canadian Society of Civil Engineers, an inspection trip was arranged to permit the members to visit the steel manufacturing plant of Armstrong-Whitworth of Canada, Limited, at Longueuil, a suburb of Montreal. At that time *The Canadian Engineer* secured a brief description of the plant from Charles F. Bristol, B.Sc., construction engineer of the Armstrong-Whitworth firm, to be published with the detailed story of the proceedings at the annual meeting. Later, the council of the society decided to make no inspection trips this year, so that part of the program was cancelled, but Mr. Bristol's article, which follows, will nevertheless interest many engineers.

The plant is divided into nine manufacturing departments, *viz.*, crucible pots, crucible melting furnaces, electric furnaces, open hearth, rolling mills, hammers and hydraulic presses, annealing furnaces, small tools, wheels and tires.

With but one or two exceptions, the building is subdivided into bays, served by overhead travelling cranes. A special feature is an alley-way between each pair of bays. These alley-ways contain the numerous heating and annealing furnaces, and permit of individual smoke-stacks on each furnace without in any way interfering with the cranes.

The side and front walls are of reinforced concrete. About 70 per cent. of their area is glass. The columns and trusses are of steel construction. The back wall is wood studding covered with expanded metal on both sides and plastered with a strong cement mortar. This type of wall is easily removed when additions are required, and, as originally planned, any department may be increased over 1,000 feet in length.

The crucible pot manufacturing department is situated in the first bay, 50 ft. x 100 ft. long, served by means of a hand-operated overhead travelling crane. This department manufactures both clay and graphite crucibles.

The crucible steel melting furnaces are situated in the second bay, 50 ft. wide by 100 ft. long, served by means of a 5-ton electrically operated overhead travelling crane. The crucible furnaces are both coke and oil-fired types, and have a total capacity of 48 pots to a heat. The crucible pot and ingot annealing furnaces are situated in the alley-way in front of the crucible furnaces.

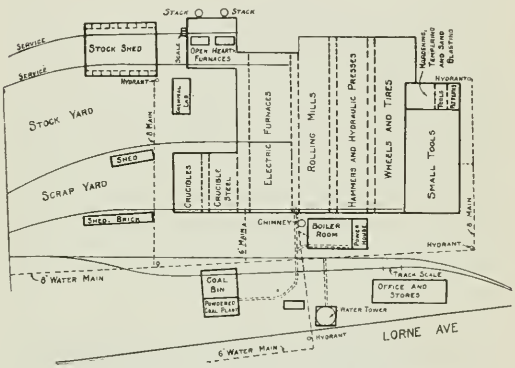
The electric furnace bay is 75 ft. wide by 275 ft. long. It is served by two 15-ton electrically operated overhead travelling cranes, and contains one 3-ton Heroult electric arc furnace for making all kinds and grades of alloy steel, and three 6-ton Heroult electric arc furnaces for making wheel and tire steel. The transformers and various electrical equipment for operating each individual furnace are placed in totally closed-in compartments in the alley-way adjoining, and very close to the furnaces. The electric current is 3-phase, 63 cycles and is transformed at the furnaces from 22,500 to 110 volts.

The open hearth building, at right angles to the electric furnace department, contains two 18-ton basic open-hearth furnaces. These furnaces are primarily intended for melting only, while the refining is done in the 6-ton electric furnaces, as a steel superior to either basic or acid open-hearth steel is required. Owing to the relative positions of the open-hearth and electric furnace departments, each may be added to as occasion may arise. A 25-ton electric overhead travelling crane serves the ladles, and a Wellman-Seaver-Morgan ground-type charging machine is installed on the charging platform.

The rolling mill bay contains one 12-inch two-high, 5-stand hand-mill, driven by a 300-h.p. variable speed d.c. motor; one 9-inch, three-high, 5-stand hand-mill, driven by a Porter-Allen engine; and one 20-inch, three-high, 2-stand hand-mill, driven by a William Todd engine. The bay is 50 ft. wide by 300 ft. deep and is served by one 5-ton electric overhead travelling crane.

The steam hammers and hydraulic presses are in a similar bay, parallel to the rolling mills and containing one 4-cwt., one 8-cwt. and one 12-cwt. Massey tilting hammer; one 1-ton Massey hammer; one 3-ton Bertram hammer; and one 500-ton, one 600-ton, one 1,000-ton and one 2,000-ton steam intensifier hydraulic press. The lower end of this bay is served by a 5-ton electric overhead travelling crane, while the upper end has an electric overhead ingot server. The 2,000-ton and 600-ton presses are for the various forging operations necessary for the manufacture of wheels and tires, while the other presses and the hammers are for forgings and for cogging, billetting and tilting tool steel.

The last bay, 50 ft. wide by 300 ft. long, contains the tool steel annealing furnaces, the repair shop, wheel and



General Plan, Armstrong-Whitworth Plant

tire rolling mills, wheel and tire marking press, and tire-centering press. This bay is served by two 5-ton cranes.

The tool manufacturing shop is separated from the previously mentioned shops by a reinforced concrete wall and contains the very latest automatics, milling machines, relieving lathes and grinders of all descriptions required for the numerous operations pertaining to the various tools manufactured.

The hardening department is a continuation of the tool room, separated therefrom by a concrete wall, and contains a variety of semi-muffle furnaces for heating the various tools for hardening.

The boiler room contains two 500-h.p. B. & W. water-tube boilers and two 500-h.p. Goldie & McCulloch water-tube boilers equipped with superheaters. Separated from the boiler room by a wall is the motor-generator room, containing two synchronous motor generator sets with control switches for all shop lines, also a Goldie & McCulloch steam engine direct connected to a 2,200-volt a.c. generator. The direct current generators are of the three-wire type, supplying 500 and 250 volts. The synchronous motors are wired for 2,200 volts, but differ from the ordinary synchronous motor inasmuch as they start up as induction motors. The sub-station is equipped with lightning arresters, oil switches and transformers, stepping 22,500 volts down to 2,200 volts.

The powdered-coal system was installed by the Bonnot Company. It weighs, drys and crushes the coal, mixes air in definite proportions with the pulverized coal, and blows same through pipes to the boilers and furnaces scattered throughout the plant.

Three of the reheating furnaces are equipped with waste-heat boilers; one with a 125-h.p. horizontal return tubular boiler, and each of the other two with a Goldie & McCulloch 250-h.p. water-tube boiler, with superheater. In the event of there being insufficient waste heat to fire the larger boilers, arrangement has been made to supplement same with powdered-coal jets.

FIRST GENERAL PROFESSIONAL MEETING OF CANADIAN SOCIETY OF CIVIL ENGINEERS

The first general professional meeting of the Canadian Society of Civil Engineers, which is to be held next Tuesday and Wednesday at Toronto, has been called under section 44 of the new by-laws of the society, which reads as follows:—

"General professional meetings of the society may be held once a year in each province, subject to the approval of the council, and also at such places and times as the council may direct, for the presentation of papers and the discussion thereof, visiting engineering works of interest and generally for professional intercourse. Such meetings shall be conducted by the officers of the provincial division in the province in which the meeting is held, or if no provincial division has been established therein, by the officers of a branch in that province, to be selected by the council. The secretary of the society shall act as secretary of the meetings and shall furnish a report of the meeting for the transactions of the society."

CANADIAN SOCIETY OF CIVIL ENGINEERS IN THE MARITIME PROVINCES

Fraser S. Keith, secretary of the Canadian Society of Civil Engineers, was in Halifax recently in connection with society affairs and met as many of the local members as could conveniently get together on short notice, at an informal supper on Friday evening, March 8th.

As a result of a meeting with a committee of the Nova Scotia Society of Engineers, a resolution was adopted, subject to ratification by both societies, approving of an amalgamation of the Nova Scotia Society with the Canadian Society of Civil Engineers. Mr. Keith at the same time discussed with local members the affairs of the Canadian Society in general, with special reference to recent changes in the by-laws and the change in name.

It was unanimously decided to make application to the council of the Canadian Society of Civil Engineers for the formation of a branch in Halifax. This application will be dealt with this week by the council of the Canadian Society, as will also an application for the establishment of a branch in St. John, N.B.

It is expected that the Hudson's Bay Railway will be completed by the Dominion Government within the next three months. Only 80 miles of steel remain to be laid, and the last bridge has been completed. In the near future, a new route will be open from Great Britain to Japan and the Far East by way of Hudson's Bay and Prince Rupert.

TESTS OF STEEL COLUMNS

After a very extensive series of tests, the special committee on tests of steel columns, appointed by the American Society of Civil Engineers in 1909, has submitted its final report.

The report covers column sections designed to avoid the necessity of latticing or battens and tested with square ends. It covers one grade of structural steel—the ordinary structural grade—with a desired ultimate tensile strength of 60,000 pounds per square inch.

The earlier tests showed a decrease in unit ultimate strength of the heavy columns when compared with the light ones. In seeking to account for the falling off in strength of the heavy material, the committee learned that it was necessary to look beyond the differences in the ratios of widths to thicknesses of outstanding legs, and variations of cross-section. The only remaining element which could be charged with responsibility appeared to be the metal itself, and though the intention had been to secure material of a uniform grade, a more careful and thorough investigation disclosed the fact that the attempt had not been successful.

Not finding an explanation of the falling off in strength of the heavy material in the record of mill specimen tests, the Bureau of Standards then took some of the long columns, which had already been tested, and cut them into lengths to give a slenderness ratio of $\frac{l}{r} = 20$.

These short columns showed that the unit ultimate strength of the heavy columns was considerably more than that of the light ones. Both series indicated a fairly definite point at which permanent set occurred, and showed that this point was lower for the heavy columns than for the light ones, indicating that the increased ultimate strength of the heavy ones came about from the block action of the short, heavy material, and that the elastic limits or yield points are the true indicators of the strength of the two different thicknesses of material.

Tests of short columns having a slenderness ratio of $\frac{l}{r} = 20$, made of material which had not been previously stressed, confirmed these results and the belief that the strength of columns is governed, not by the ultimate tensile strength of the material but by the point at which there is marked departure from an elastic condition.

To investigate the question of this critical point, the Bureau of Standards proposed some supplementary specimen tension and compression tests, to be made from pieces, 5 ft. in length, which had been provided from each melt at the time the material was rolled. These 5-ft. pieces were in the nature of coupon material from the columns, and had not been subjected to stresses in the testing of the columns. Table I. is a summary of the averages for these supplementary specimen tests and of the averages of the mill specimen tests.

The ultimate strengths shown on the supplementary specimen tests were very close to the ultimate strengths given for the specimen mill tests, and neither the ultimate strengths from the supplementary tests nor from the mill tests indicates the falling off in strength of the thicker material. It also was evident that the yield point, as recorded by the ordinary commercial tensile specimen tests, even when the machine is run at comparatively slow speeds, as was done in the Pittsburgh Laboratory of the Bureau of Standards, did not give the correct index of the strength of the material. The committee concludes that "it appeared necessary, therefore, in order to predict the

strength of a column, to determine the nature of the metal by some other means than those generally used."

For the purpose of studying the column tests, the committee gave careful consideration to the discussion held by the American Society for Testing Materials at its annual meeting, June, 1916, on the relation between proportional limit, elastic limit, and yield point, to find whether it was possible to determine some point which, for practical purposes, might be easily located, clearly defined, and at the same time represent the limit where the metal ceases to have structural value. None of the terms defined by the discussions of the American Society for Testing Materials appealed to the committee as having these qualities. In searching for a more satisfactory definition, the committee considered a modification of the suggestion made some years ago by the late J. B. Johnson, M.Am.Soc.C.E. The committee has defined the critical point as the point which is determined graphically by drawing a line tangent to the envelope of the stress-strain curve, having a slope

Table I.—Summary of Results of Mill Tests and Bureau of Standard Tests

Type.	Mill Specimen Tests Made at Pittsburgh.			Bureau of Standards Specimen Tests.			Average U.L.P. of full-size columns $\frac{l}{r}$ = 50 and 85	Average ultimate strength of full-size columns $\frac{l}{r}$ = 50 and 85
	Average drop of beam.	Average ultimate strength	Number of tests.	Average U. L. P.	Average ultimate strength	Number of tests.		
1	34 000	58 900	7	33 100	59 000	8	28 300	32 000
1A	33 300	59 600	7	29 800	56 200	2	25 000	28 600
1B	36 400	59 600	4	31 100	57 000	1	26 200	27 700
2	36 600	57 700	5	32 500	58 800	8	28 100	32 900
2A	36 900	59 700	4	30 200	58 400	6	26 800	31 400
3	39 800	55 600	5	34 100	55 400	4	28 200	33 300
3A	37 900	59 200	2	.....	.....	.....	25 500	28 800
4	36 600	58 100	5	33 800	58 000	13	31 800	35 400
4A	37 700	59 400	4	27 100	59 700	13	22 900	27 900
5	.....	.....	.....	37 600	61 500	2	33 800	36 200
5A	.....	.....	.....	33 300	57 900	3	30 900	33 800
5B	.....	.....	.....	22 600	56 400	12	20 000	24 400
6	34 600	57 600	9	.....	.....	.....	24 500	30 400
6A	33 300	60 400	5	.....	.....	.....	22 600	29 500
7	34 600	59 400	5	33 500	61 600	3	30 000	32 500
8	39 300	56 300	6	.....	.....	.....	31 200	34 200
8A	37 800	58 700	3	.....	.....	.....	29 400	32 300
10	37 600	58 100	16	.....	.....	.....	26 800	34 000
10A	37 600	61 700	5	.....	.....	.....	25 200	30 100

of one-half of the last run-up line for its straight, or nearly straight, portion. So as not to confuse this with former definitions of yield point or elastic limit, the committee has adopted a new term, and calls this the Useful Limit Point, or U. L. P.

In straining a column, there is a point beyond which its structural value is uncertain, and consequently unsafe to rely upon. This point lies somewhere above the region of perfect elasticity and well below the place where manifest yielding occurs. For the study of column tests, the U.L.P. as above defined, states the committee, seems to fulfill these conditions satisfactorily. Careful observations and plotting of the stress-strain curve locate it without chance for controversy. The method is applicable to both tension and compression tests.

In the early days of the iron and steel industry, it was the custom of engineers to adopt a working unit stress for tension members of one-quarter of the unit ultimate specimen tensile strength, and they spoke of a factor of safety of four. When we consider the distortions produced by the stretching of tension members after being strained above the yield point, and that manifest yielding and failure occur in columns when the stress reaches about one-half of the specimen ultimate strength in tension, it is evident that the factor of safety obtained by this older method was nearer two than four.

In a structure having both tension and compression members, the desideratum in determining a factor of safety is to obtain a working stress so that all parts of the structure have an equal capacity to resist the applied loadings.

The committee made no original investigations of the strength of full-sized riveted tension members, and, therefore, could not make as definite a comparison with full-size riveted columns as would be desirable. It may be stated, however, that the usual working stress in tension is approximately one-half the elastic value of the metal, and the committee assumes that, in view of all the factors mentioned above, columns should have a safety factor of at least two, based on the U.L.P., in order to be on a parity with tension members.

The average U.L.P. of all the column tests in the committee's program for slenderness ratios, $\frac{l}{r} = 50$ and $\frac{l}{r} = 85$, is 27,200 lbs. per square inch. The U.L.P. for the extra heavy section, Type 5B, slenderness ratio, $\frac{l}{r} = 50$, which is the lowest value observed, is 19,700 lbs. per square inch, which is 28 per cent. below the average, and this appears to be too wide a margin of under-run for safety. It would seem to be necessary, therefore, in recommending a working stress, to assume a U.L.P. lower than the average of all the tests. If we take as a safe assumption the mean between the lowest value and the average value, this mean will be 23,500 lbs., or approximately 24,000 lbs. per square inch. The factor of two applied to 24,000 lbs. will give a safe working value of 12,000 lbs. per square inch for columns, which stress the committee would recommend. In this recommendation it is assumed that only static loads are being dealt with, and that a percentage of the static stress will be added to cover the impact due to moving loads.

Lacking further experimental data, the committee regards it as unwise to assume a higher working stress than 12,000 lbs. per square inch for columns in which the ordinary grade of structural steel (60,000 lbs. ultimate tensile strength desired), is specified. It is, of course, impracticable to know in advance the precise U.L.P., or any other factor of strength, which the metal used may develop. It would be possible to specify the desired value, and, in important structures, to inspect the material with sufficient care to insure the rejection of all which failed to come up to the specification.

The committee would recommend that this working stress of 12,000 lbs. be used for columns up to a slenderness ratio of $\frac{l}{r} = 80$, and, above this slenderness ratio, the committee would reduce the working stress to allow for uncertainties. The committee realizes that the results as given in its program show that the slenderness ratio has a comparatively small effect, up to values of $\frac{l}{r} = 120$. It must be remembered, however, that the tests were made by the Bureau of Standards under extremely favorable conditions, the ends of the column being scraped so as to give a bearing precisely perpendicular to the axis of the column. The committee would recommend a working stress of 8,000 lbs. per square inch for slenderness ratio of $\frac{l}{r} = 120$, and that the working stresses for

slenderness ratios between 80 and 120 be determined by interpolation.

The committee realizes that the working value recommended for short columns is lower than that given by the American Railway Engineering Association formula, which has been in use for a number of years. Originally this formula was $\frac{P}{A} = 16{,}000 - 70\frac{l}{r}$ and, later, the upper section was truncated to a maximum working stress of 14,000 lbs. The committee feels, in view of its studies in regard to the U.L.P., that there is no warrant for high working stresses in short columns.

SASKATCHEWAN LAND SURVEYORS MEET

The eighth annual meeting of the Saskatchewan Land Surveyors' Association was held in the Parliament Buildings at Regina, Sask., on Monday and Tuesday, March 4th and 5th.

The meeting was well attended, many members being present from various parts of the province, and a keen interest was displayed throughout all the sessions in the work of the association. A number of visiting engineers from the Department of Highways were in attendance.

The meeting was devoted mainly to a study of rural roads. A number of valuable papers dealing with the various phases of the location, construction and maintenance of roads were presented by W. M. Stewart, S.L.S., of Saskatoon, Sask., which brought forth a lively discussion.

The series of papers dealing with roads consisted of: "Rural Road Development—Legislation and Control," "The Planning of a System of Highways," "Financing Rural Road Work," "General Features of Construction and Principles of Design Applicable to All Road Types," "Earth Roads," "Sand, Clay and Top Soil Roads," "Types of Road Surfaces Within the Means of the Average Saskatchewan Rural Municipality," "Gravel Roads."

In addition to the above, papers were also read and discussed on the following subjects: "Principles of Drainage Assessment," by H. G. Phillips, S.L.S.; "The Railroad Spiral in Relation to Land Surveys," by E. C. Brown, S.L.S.

On Monday evening a banquet was held at the Assiniboia Club, at which the retiring president, R. W. E. Loucks, acted as chairman. The guests included the Hon. S. J. Latta, Minister of Highways for Saskatchewan, and H. R. Mackenzie, as official representative of the Saskatchewan Branch of the Canadian Society of Civil Engineers. At this dinner W. T. Thompson, one of the pioneer surveyors of the province, read a very interesting paper describing a canoe trip "Down the Saskatchewan from Prince Albert to The Pas." The Hon. Mr. Latta addressed the meeting, pointing out the policy of the Department of Highways towards road building.

A spirited discussion then followed dealing with various aspects of rural roads, in which the majority of those present participated.

The following officers were elected for the ensuing year: President, W. T. Thompson, Regina, Sask.; vice-president, E. C. Brown, Winnipeg, Man.; secretary-treasurer, H. G. Phillips, Regina, Sask; executive council, W. M. Stewart, Saskatoon, Sask.; R. W. E. Loucks, W. A. Begg, and S. Young, Regina, Sask.; auditors, W. R. Reilly, C. S. Cameron, Regina, Sask.

PROBLEMS OF MODERN INDUSTRY*

By W. L. Hichens

UNLESS industry is recognized as primarily a national service in which each individual is fulfilling his function to the best of his ability for the sake of the community, in which private gain is subordinated to public good, in which, in a word, we carry out our duty towards our neighbor—unless we build on this foundation there is no hope of creating the House Beautiful. If each man thinks of making his pile by all the means that economic individualism allows, if class bands itself against class, trade union against employers' federation, firm against firm, to secure the greatest share of the world's goods in unrestricted competition, social life must inevitably break down and anarchy reign supreme. Some of the practical steps that this principle seems to suggest in relation to certain of the problems that confront industry to-day are briefly indicated below:—

(1) I think it follows that no business is entitled to make unlimited profits. The present theory is that the residuum, however large it may be, after defraying the costs of production, should go to capital. This, I submit, is unsound. Labor, the entrepreneur class, capital, and the consumer, are all partners in the business of the community, and no one class is entitled to benefit unduly at the expense of another. The principle of the Profits Tax should therefore be retained after the war. The present tax, of course, was intended as a temporary measure, and a standard of profits based on pre-war earnings is quite unsuited to permanent conditions. It would be necessary to fix a standard rate of interest for the capital invested in each class of trade or industry, and a proportion (I suggest a substantial one) of any excess profits over that standard should accrue to the State. In any such scheme it would be necessary to provide that adequate allowances are made for depreciation and for reserves to secure the stability and development of business. The wholly inadequate provision for depreciation allowed under the Income Tax Regulations to-day has done serious injury to the industries of this country. It has encouraged over-capitalization; it has hampered the scrapping of old and the substitution of modern machinery; it has given us a retrograde in place of a progressive standard. Effect must somehow be given to the principle that no section of society is entitled to an unlimited share of the wealth of the community, that free competition has proved an impossible solution, and that profit-sharing with the State, which is, in the effect, an excess profits tax, is more equitable and more expedient than other forms of profit-sharing.

(2) It follows secondly that, just as capital is not entitled to an unlimited reward but must be checked by State action, so also the reward of labor must in the last resort be determined by the State as representing the community. Labor has no more right than capital to make a corner in its own commodity and hold the community up to ransom, and it, too, must bow to the will of the State. In practice it is clear that the tendency will develop for wages to be settled by joint industrial boards representing employers' and workers' organizations, but in the event of disagreement, or collusion to exploit the community, the State must have the right of intervention. It is not fitting that any party should be the final judge in its own cause, and any such claim, if successful, will inevitably lead to the disintegration of society. For the community will be

*Abstract of James Watt Lecture, delivered before the Greenock (Scotland) Society, January 18.

divided into a number of groups each fighting for its own hand, private gain will rise superior to the public good, the fundamental law of social life will be broken, and the eternal truth will be verified that a kingdom divided against itself cannot stand. I recognize that a large section of the community is not to-day prepared to accept the principle of State intervention, and I recognize also that unless it appeals to the moral judgment of the great majority of the nation it cannot be enforced and ought not to be enforced. The important thing to-day is that the verdict of public opinion should be sought.

(3) The principle of national service requires, thirdly, that the status of labor as a whole should be raised. The workers are clearly entitled to have an effective voice in regard to the general conditions under which their work is carried on. They are vitally interested in all questions, for example, affecting wages, hours of labor, apprenticeship, demarcation of work, decasualization, and they have an equal right with employers to assist in the determination of these problems. The general acceptance of the proposals for Joint Industrial Councils contained in the Whitley report is good evidence that public opinion will support the demand of labor for an improved status. If its voice is to be at all effective it follows that, as suggested in the Whitley report, district councils and works committees must be established to deal with local questions and to ensure that whatever is agreed to by the central councils is carried out locally. The more highly organized employers' associations and trade unions have already advanced far along the lines of the Whitley report, but much has yet to be done in determining precisely the powers and functions of these joint central and district bodies.

There are two points in particular which, it seems to me, deserve careful consideration. The first is the interpretation of decisions in regard to wages. At present all general increases in time rates are determined by the government, and, incidentally, I may say that it is a grave defect in organization that so many government departments meddle in labor matters. There should be one government department only—the labor department—to deal with labor questions, not half a dozen, and this salutary reform would save great confusion and waste of money. There is, in fact, a serious lack of co-ordination between the government departments. New departments have been thrown down as from a pepper pot, without a clear definition of their functions or their relations to the older departments and each other, with the result that, as in the game of "Snap," when identical cards are turned up by two or more players, a discordant noise ensues for the appropriation of the spoils, and all are as intent on the game as the boy in Theocritus, who pays no heed to the wily fox that designs to rob him of his breakfast. The solution, I submit, is a Cabinet for internal affairs, distinct from, though subordinate to, the War Cabinet, with a president of its own whose business it should be to co-ordinate the administration of domestic policy. This would give relief to the over-burdened War Cabinet, and allow serious and orderly consideration to be given to the vast internal problems with which we are faced.

But this is a digression, and I return to my point, which is that, while general increases in time rates are to-day settled by the government, individual firms still determine time rates in particular instances and all piece rates, which, in theory, should bear some definite relation to time rates. Thus the door is left open for one firm to pilfer from another, and, since leaving certificates have been abolished, the temptation has not always been resisted. It is obvious that the firms whose piece rates are highest will attract most labor, with the result that other firms will be obliged to follow suit, and this will eventually react on the time rates. Similarly in periods of depression, when labor is plentiful, individual firms can cut their piece rates and compel others to follow suit, or lose their trade. The strongest justification for restriction of output is that individual firms have it in their power to cut down piece-work rates, and in the past they have often done so when they found that under them the workers were earning very high wages. Consequently the workers have felt that in the end the result of increasing output and speeding-up has been to reduce the piece-work rates and restore the normal balance of their earnings; but, unnaturally therefore, they have concluded in favor of maintaining a normal output of work. It is quite clear that a mistaken piece rate must be open to revision downwards as well as upwards, and the pledge given by the government at the beginning of the war that no piece rates would be reduced was a benevolent blunder. What they should have done was to ensure that piece rates were not arbitrarily altered, and that due care was exercised in the fixing of all rates. The responsibility for fixing piece rates and special time rates—in other words, the detailed interpretation of wages agreements—should rest, not on individual firms, but on the joint district councils, which are to be linked up with the joint industrial councils. This would mean that these councils would require a competent staff of rate-fixers to deal with each case promptly, but a more than corresponding reduction could probably be made in the rate-fixing staffs of individual firms, and the gain that would result from placing the settlement of piece rates on a basis that would establish confidence is incalculable.

It is sometimes claimed that labor should have an effective voice not merely in regard to the general policy and conditions of industry, but in the management of each individual business. This claim is vaguely put forward and has never been clearly thought out; it makes its appearance usually under the guise of a demand for the democratization of industry. The political analogy implied in this phrase is attractive, but misleading. For whereas a State cannot at one and the same time be an autocracy, an aristocracy, and a democracy, it is possible for every variety of organization to co-exist in industry. The general policy and conditions of industry should, it is true, apply to each firm in an industry, and therefore it is right that labor should have an effective voice in determining them and seeing that they are carried out, through joint industrial councils and district committees. But every degree of variation is possible in the detailed organization of individual businesses. There is ample scope in industry for everyone to select or develop the type of organization that suits him best, and it seems to me that each man is entitled to choose for himself. Unrestricted competition is an evil, but its complete elimination spells stagnation; for a healthy rivalry between one type of organization and another and between one firm and another is the life-blood of efficiency. Hence, subject to the observance of the general policy and conditions of industry, each business should be organized on whatever lines seem best to those who are responsible for its direction. I do not agree, for example, with the suggestion so often made that the power of dismissal is too big a responsibility to be exercised by any single employer, and that there should be a right of appeal to some outside body. Given an adequate system of unemployment benefit, it is vital to the success of industry that those responsible for the management of a business should be entitled to select their own employees. The secret of success in business lies very largely in the wise selection of men, and if that re-

sponsibility is taken away from the management a blow will be struck at the very roots of our industrial supremacy.

(4) The fourth point in the application of the general principle of national service is, strictly speaking, rather a necessary preliminary to, than a consequence of, the principle. I refer to the question of the reduction of hours of labor, which is one of the most important problems awaiting solution. The first step on the return of peace should be the establishment of an eight-hour day as a first instalment towards still farther reductions, if experience shows that this is possible consistently with the material requirements of civilized existence. Moreover, it should be arranged that each worker who has been with a firm a whole year and has kept good time should be given a holiday on full pay. The distinction between a strike and a holiday should be more marked than it is now, and the same absence of pay should not characterize both.

(5) But the reforms indicated above will require large sums of money, and there are many others, such as housing and education, the cost of which will be formidable. Moreover, these reforms will be of little or no avail unless a high standard of wages is established. Seeing that we are so largely dependent on our foreign trade, in which prices are regulated by international competition, it is quite clear that we shall not be able to meet the bill unless we can effect drastic economies in production and largely increase our output. If all strikes can be prevented, and regarded, as they should be, as the unhealthy excrescence of a semi-civilized age, the addition to our national wealth will be very great. An average of 18 million working days per annum was lost owing to trade disputes in the four years before the war, to which must be added the indirect losses involved by the dislocation of industries not primarily affected. But an even greater gain will be made if the policy of restricting output is abandoned. Disastrous though the policy is to the workers themselves, as well as to the rest of the community, we shall be indulging a vain hope if we think it will be abandoned so long as the theory holds the field that capital is entitled to the residuum of profit after the costs of production have been defrayed. Unless it is made unmistakably clear that industry is run for the benefit of the whole community and not for the enrichment of certain classes, restriction of output will continue, and the reforms that are so urgently needed will be sadly hampered. A third important factor in improved production is the substitution of up-to-date machinery for old and the extension of labor-saving devices. It is clearly in the general interest that machinery should be substituted for hand labor wherever practicable, just as it is a social duty to secure that no one is paid a wage below what will support a civilized existence. In fact, the latter cannot be secured without the former. It would be a mistake to suppose that the opposition to the reforms involved in the introduction of improved mechanical devices and improved organization comes from the workers alone. Vested interests play an even more powerful part in thwarting progress, and ingrained habits present a formidable obstacle to far-reaching schemes of reform.

One instance of wasted effort I should like to refer to briefly because of its far-reaching importance. I mean the waste involved in unrestricted competition. Certain forms of competition are healthy and cheapen production, but others are sadly wasteful. The rivalry in economical production—so long as wages, hours, and general conditions of work are safeguarded—seems to me healthy, and I believe it is better for a country to have a large number of small manufacturers than a few big trusts; this also accords more with the genius of our race, whose sturdy independence and self-reliance have built up an Empire containing a quarter of mankind. Nor do I believe that the economies resulting from manufacture on a gigantic scale are very great.

But big selling organizations are undoubtedly more economical than small ones. What is wanted, therefore, is big selling combinations, which should also promote research work, and a variety of manufacturing units. The money that is wasted every year in travellers, in touting for orders by means which are often degrading, in overproduction, runs into enormous figures. But the remedy of syndicating the produce of each industry is full of difficulty; it tends to stagnation, to the exclusion of newcomers and to inflation of prices, for the evil of rings in the past has been that they have thought more of keeping prices up than of cutting costs down. These evils are not insuperable, and attention should be concentrated on the establishment of big selling organizations. The principle is not, of course, immediately applicable in all industries, but it might be applied at once with great advantage to many of the standardized trades, and it might be encouraged where it already exists.

TORONTO MAY ESTABLISH PIGGERY

Street Commissioner George B. Wilson and Property Commissioner D. Chisholm, of the city of Toronto, have presented a joint report to the aldermanic sub-committee on waste disposal, recommending the establishment of a municipal piggery, to commence with 500 hogs. They state that the initial expense involved is $15,250, made up as follows:—

One 5-ton motor truck, $8,000; annual operation and maintenance of truck, $3,600; one sterilizing apparatus, $2,000; one foreman at farm, $1,000; 200 cans, $450; incidentals, $200.

The proposal involves the separation by the citizens of the class of material required, and it is intended to collect this in a limited section of the city, beginning with the residential section known as Rosedale. Householders from whom collections are to be made, are urged for patriotic reasons to assist the city by carefully conserving all edible wastes and retaining the same in separate receptacles for collection twice a week during the winter months and three times a week during the summer months.

At the start it is the intention to make provision on the present collection equipment of the department to enable the drivers to keep the hog-feeding material entirely separate from the other collections made by the same vehicle. The material will be transferred to the motor truck at the incinerator. Separate collections may be instituted at a later date. The food value of the edible garbage laid down at the Industrial Farm, where the piggery will be established, is said to be approximately $15 per ton. As it is expected to deliver five tons a day, the delivery is estimated to be worth $22,500 per annum. From this amount, however, must be deducted the expenses of the enterprise. The city council are asked by the report to include $15,250 in the current year's estimates of the property department, to cover the expenses outlined above.

The sterilizer is required by the regulations enforced under the direction of the Veterinary Director-General of Canada. A man who keeps one pig is not hampered by any feeding regulations. More than one pig, but not more than twelve pigs, may be fed with pot-boiled garbage. If more than twelve are kept, a sterilizing plant must be installed to heat the garbage to 200 degrees.

PROVINCIAL CONTROL OF FORESTS

The recent proposal of Hon. Edward Brown, provincial treasurer of Manitoba, to retire the provincial debt by realizing on the natural resources of the province, was noted in these columns two weeks ago. A circular, just issued by the Canadian Forestry Association, takes issue with Mr. Brown and with the other Western political leaders who have brought forward the contention that Manitoba, Saskatchewan and Alberta should be placed upon the same basis as the older provinces in respect to ownership of their natural resources. This Association is a non-government, non-commercial body of 5,500 Canadian citizens, 1,200 of whom reside in the prairie provinces.

With the political side of the long-standing dispute over control of natural resources in the prairie provinces the Canadian Forestry Association states it is not concerned. So peculiarly, however, is the question related to proper management of the Western forests that some reference to it at this time, it thinks, is essential in the public interest.

The Association states that the bulk of the citizens of the Western provinces have an impression that the forests would constitute an immediate source of revenue to the provincial treasury and that in demanding control of the forest resources they are asking the Dominion to enhance their cash income. The ownership of the Western forests, however, is an immediate financial liability to the Dominion government, and the total income from Western forests does not equal the total outlay for protection and improvement. The Dominion Forestry Branch spends $445,000 annually on forest protection in Manitoba, Saskatchewan and Alberta, while the total revenues are approximately $39,000.

"If the forests are handed over to the Western provinces, they must accept the situation as it actually is," says the Association. "Instead of adding to their revenues, they would then have to find at least $200,000 from some fresh source with which to pay the cash deficit on one year's handling of their new forest possessions. More than that, they would, in all likelihood, automatically forfeit the provincial subsidies paid by the Dominion government amounting to: Manitoba, $409,007; Saskatchewan, $562,500, and Alberta, $562,500, as a Dominion allowance in lieu of public lands. These subsidies are paid as compensation for Dominion control of the natural resources, and would lapse with any transfer of title to the lands. What proportion of the subsidies is represented by the forest resources is not ascertainable, but assuredly it would represent a large sum for each province." These are important considerations and should have the attention of the provincial authorities during their discussions.

STEEL PLANTS EXPECT CONTRACTS

That all steel plants in Canada will probably be operating at full capacity throughout the year under heavy demand, and that large new munitions contracts are expected from the United States and Great Britain, are opinions expressed by Colonel Thomas Cantley, chairman of the board of directors, Nova Scotia Steel and Coal Company.

The production of steel ingots and direct castings in Canada in 1917 was approximately 1,700,000 tons, creating a new record, the previous banner year being 1916, when about 1,300,000 tons were produced. The production of pig iron likewise advanced in 1917 to 1,200,000 tons. About 13,000 tons of this came from electric furnaces The electric furnaces accounted for 45,000 tons of steel last year, as against 19,000 tons in 1916.

TRADE RETURNS

The transportation difficulties, rail and ocean, are reflected in the trade figures. Our exports of agricultural products in January were valued at only $26,000,000 compared with $91,000,000 in the previous month, despite the urgent demand of the United Kingdom for our products. A better record was made in regard to manufactures. In December, the total volume of exports under that head was the smallest during the past year. A considerable improvement occurred in January when exports of manufactures were valued at $41,383,115, an increase of nearly $8,000,000, representing more than 40 per cent. of the total exports of all classes. Another satisfactory gain was $4,500,000 in "animals and their produce," while increases were shown under the heads of "the mine" and "the fisheries." How our export totals during January and December last were made up, is shown in the following table:—

Exports of—	January, 1918.	December, 1917.
Mine	$ 5,528,992	$ 5,026,041
Fisheries	3,390,587	3,016,059
Forest	3,110,324	3,836,909
Animals	15,918,079	11,433,910
Agricultural	26,390,294	91,216,447
Manufactures	41,383,115	33,635,790
Miscellaneous	494,893	246,763
Total	$96,216,284	$148,411,919

Our imports in January were valued at $60,000,000 compared with $61,000,000 in December and $107,000,000 in May. Imports, which have been decreasing steadily since the summer of 1917, largely because of the difficulty of securing raw materials in the United States, were the smallest reported in any month in more than a year. Because of a decrease of $13,000,000 in the import figures the net trade balance in favor of Canada was in January last nearly $9,000,000 higher than in January a year ago, and a new record for the month. If our imports continue to decline and our exports increase, the trade balance will rapidly improve. At the same time, as a large part of our imports are raw materials from the United States and as much of the product is finished here for export, a decrease of imports will to some extent affect the volume of our export trade also. Our trade balance may possibly be improved by a compulsory reduction of the importation of articles which may properly be considered luxuries. This matter is having the consideration of the War Trade Board.

CONCERNING STEEL SHIPBUILDING

In answer to the enquiry of the St. John board of trade as to whether the government would furnish the builders with steel plates in the event of a steel shipbuilding yard being established in St. John by private capital, the deputy minister of marine advises that it is the intention of his department in connection with the proposed programme of shipbuilding to enter into contracts only with such firms as are now equipped with the necessary machinery and labor for the delivery of steel steamers complete.

The suggestion that St. John is favorably situated for the establishment of a steel shipbuilding plant has brought an enquiry as to whether there is available here a water lot with deep water frontage of 5,000 feet and a depth of 1,500 feet that would be suitable for a comprehensive shipbuilding plant. The size of the plant contemplated would involve an expenditure of between eight and ten million dollars and would employ from five to seven thousand men all the year round.

The British Aluminium Company, Limited, whose head office for Canada is at 60 West Front Street, Toronto, has distributed a most useful article in the shape of a perpetual calendar combined with paper weight. Those who are fortunate enough to secure one of these desk friends will, no doubt, find it very handy.

CANADA'S SHIPBUILDING ACTIVITIES

Shipbuilding contracts placed in Canada by the Imperial Munitions Board since March 1st, 1917, constitute the biggest year in shipbuilding this country has ever seen. Contracts have been let in the last twelve months for 46 wooden ships with a total tonnage of 128,000, representing $24,500,000, and for 43 steel ships, totalling 211,300 tons, worth $40,000,000, or a total value of $64,500,000. Four steel ships aggregating 13,900 tons, the individual boats having a tonnage of 4,200, 3,400, 4,500 and 1,800, have been completed. Four wooden ships have already been launched and several others are ready to take the water. New yards were opened during the year at Welland, Vancouver, and Toronto. All yards for the construction of wooden ships are new or have been added to.

The value of the contracts let in the different provinces is as follows:—Nova Scotia, $1,340,000; New Brunswick, $1,000,000; Quebec, $11,600,000; Ontario, $19,240,000; British Columbia, $31,434,000.

Contracts in Provinces

In British Columbia nine steel ships, each of 8,800 tons, worth $14,750,000; two of 4,600 tons, worth $1,679,000, and one of 4,500 tons, worth $905,651, or a total of $17,334,651, have been contracted for, along with 27 wooden ships, worth $14,100,000.

In Ontario 25 steel ships were contracted for. These comprise 13 of 3,500 tons, nine of 3,400 tons, one of 4,300 tons, and two of 2,900 tons, a total tonnage of 86,200 tons, representing $17,240,000. In addition to this four wooden ships, totalling 11,200 tons, worth $2,000,000, have been contracted for.

In Quebec four steel ships of 7,000 tons each, valued at $5,600,000, and twelve wooden ships of 2,800 tons worth $6,000,000, representing a total value of $11,600,000, have been contracted for.

In New Brunswick two wooden ships, each of 2,800 tons, worth $1,000,000, are contracted for.

In Nova Scotia two steel ships of 1,800 and 2,400 tons, worth $840,000, and one wooden ship at $500,000, are contracted for.

In 1918 Tonnage Will Be 400,000

According to a report of the Imperial Munitions Board it is reasonable to suppose that the approximate total tonnage for 1918 will be about 400,000. The approximate tonnage of wooden vessels being built by the Imperial Board on the two coasts, the Great Lakes and the St. Lawrence River is about 146,000. Figures as to the exact number of men employed in this programme are not available, but assuming an average labor cost per ton it is stated it will not be far from the equivalent of 25,000 men continuously employed.

In view of the foregoing, the figures with respect to the tonnage constructed in Canada in past years is of interest. For instance, 190,756 tons were constructed in 1874 when wooden ship construction was at its height, and each year since then has shown less activity until the war years. In 1880 the tonnage constructed was 65,441; in 1885, 41,179; in 1890, 52,378; in 1895, 16,270; in 1900, 22,326; in 1905, 19,781; in 1910, 22,283, and in 1914, 43,346.

For Imperial Munitions Board

At present practically every shipbuilding plant in Canada that is equipped for building steel ships is making ships for the Imperial Munitions Board. Just as soon as each berth becomes vacant it is being taken up by the Dominion government in connection with the large shipbuilding programme announced by Hon. C. C. Ballantyne, minister of marine and fisheries, early in the year. Following are the details of conditions in the different shipbuilding plants of Canada:—

Two berths are vacant at Canadian Vickers, Limited, Montreal, with whom the government has entered into contract to fill the berths at once. Arrangements have also been made to fill berths becoming vacant in May, August and September with 8,200-ton ships.

Arrangements have been made with the Collingwood Shipbuilding Company to fill one berth now vacant with a 3,800-ton ship as rapidly as men can be found. It is also expected two 3,000-ton ships will be started, one in April and one in May.

The Wallace Ship Yard, Vancouver, will commence building a 4,350-ton ship early in May. They also propose building a 5,000-ton standard ship at an early date.

The government has made arrangements with the Port Arthur Shipbuilding Company to fill two berths vacant before July with two 3,000-ton ships, canal size boats.

The Polson Iron Works, Toronto, will fill four berths vacant in October with four 3,000-ton ships.

Get Steel from United States

The Canadian Allis-Chalmers, Toronto, say they can build six ships before June, 1919, and will start as soon as berths become vacant.

Messrs. Coughlan & Sons, Vancouver, find it impossible to commence further work this year. They are building ships for the Imperial Munitions Board.

The Davie Shipbuilding Company, Quebec, will fill a berth as soon as vacant with a 5,000-ton ship.

In the meantime the department of marine and fisheries has made arrangements with the United States to secure the necessary steel to take care of shipbuilding, and at the same price as the plants across the border are paying. This steel is to be delivered to the various factories as required up to June, 1919.

It is pointed out that the establishment of new yards would only draw off men from the other yards because there are only a certain number of men available for this work. Therefore, the more the men were spread the fewer ships would be got into the water. Under existing conditions it is more important to get a few ships into service than have a large number under construction and none available.

CANADIAN NORTHERN ARBITRATION

Testifying before the Canadian Northern Railway board of arbitrators recently at Osgoode Hall, Toronto, Mr. Samuel Bertron, of the banking firm of Bertron and Briscom, New York, declared that the stock of the Canadian Northern Railway at present was worth from 50 to 60 cents on the dollar. His estimate was based on the future prospects of the railway, the growing territory through which it operated, its small grades, economical operation, and its small bonded indebtedness, which had been placed on a very low interest return. These features of the Canadian Northern Railway had attracted a group of New York financiers, who, up to the entrance of the United States into the war, had virtually consummated a proposition to finance the railway on the representations of Sir William Mackenzie. It was at the instigation of these financiers that the Loomis-Platten report on the Canadian Northern Railway was prepared.

CANADA'S TRADE HAS INCREASED

Canada's trade for the ten months of the fiscal year ending on January 31st reached a total of $2,229,493,276, according to the monthly statement issued from the customs department. This constitutes an increase of $351,208,579 over the same period last year, when the total trade amounted to $1,878,284,697. Domestic merchandise exported reached a total of $1,353,811,184 during the ten months of this year as against $960,736,072 during 1916. The exports of domestic merchandise during the month of January, this year, however, were lower than a year ago. They totalled $96,216,284 as against $99,106,259 a year ago.

Merchandise entered for consumption during the ten months this year reached a total of $823,059,701 as compared with $674,964,548 a year ago. During the month of January the total of this class was $60,677,414, which was lower than in January, 1917, when it reached $72,323,074. Foreign merchandise exported during the ten months of the fiscal year totalled $38,874,724 as against $20,470,769 for a similar period in 1917, and coin and bullion exported was $2,972,822 as compared with $196,190,607 a year ago.

The total of dutiable goods entered for consumption during the ten months ending January 31st was $460,976,255. Last year this class of goods totalled $370,646,468. Free goods during the ten months amounted to $362,082,846 as against $304,318,080 in 1917. Duty collected during the ten months of 1917 totalled $136,339,474, which was a substantial increase over the same period a year ago, when it reached $119,141,351.

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Principal Contents of this Issue

USE FUEL EFFICIENTLY!

FUEL is a subject which is engaging the minds of thousands of people in each of many countries. It is the fundamental basis of industrial development and social amenity. Hydro-electricity has changed our requirements to some extent, but—considering Canada as a whole—fuel is the prime necessary of the hour. Fuel is the metaphorical reef upon which Canada could possibly be wrecked more easily than many other countries; therefore it is highly essential to develop the conservation of the various classes of fuel, especially that which is imported.

If each consumer of fuel were to make an intensive study of the present efficiency—or, more correctly sometimes, the inefficiency—of his plant, it might be found that thousands of tons of fuel could be saved. Apart from the patriotism that is displayed by economizing in the consumption of fuel, such economy is good business. It enhances the credit of the country. It is not by the amount that we spend, but by the amount we save that our credit is measured.

Fuel has been obtained previously without much difficulty, but this winter and the war have caused engineers to consider how they could meet even more aggravated conditions such as might materialize another winter. Steps taken now to improve the methods of consumption, might help to prevent a worse plight than any we have so far experienced—and every little bit helps! Even a quarter ton of coal saved the situation at times for thousands of Canadian families this winter.

Not only the conservation of fuel, but also the problem of how to eliminate waste of the article produced, should be carefully considered. For example, some municipalities complacently allow the waterworks pumps to deliver water in quantities far exceeding the legitimate requirements of the community, thus using fuel or power which must be bought and which should be available for other and more justifiable purposes.

Conservation of fuel and power should be the fixed policy of all public authorities; because, if they are wasteful, how can the private citizen be consistently urged to economize?

"SCIENTIFIC" AND "PRACTICAL"

THE terms "scientific" and "practical" are often considered to be diametrically opposed, and there is too great a tendency on the part of individuals in either category to depreciate the other. It must be realized that the two terms are complementary, not opposed, and that both in many instances seek the same end by diverse roads.

Professor Marshall, in his "Economics of Industry," thus states the essential divergence between practical and scientific method: "It would indeed be a mistake to be always thinking of the practical purposes of our work, and planning it out with direct reference to them. For, by so doing we are tempted to break off each line of thought as soon as it ceases to have immediate bearing on that particular aim which we have in view at the time: the direct pursuit of practical aims leads us to group together bits of all sorts of knowledge, which have no connection with one another except for the immediate purposes of the moment, and throw but little light on one another. Our mental energy is spent in going from one to another; nothing is thoroughly thought out; no real purpose is made. The grouping, therefore, which is best for the purposes of science is that which collects together all those facts and reasonings which are similar to one another in nature: so that the study of each may throw light on its neighbor."

In other words, as one great thinker has said, "Superior mentality consists in a large development of the faculty of association by similarity."

The meaning of the word "practical," as applied to engineering affairs, has yet another alternative rendering. Essentially, it means experienced. The main difference between the scientific and the practical mind is that the first is concerned with fact and theory while the interest of the latter is confined to useful application of knowledge. Technicality stands, perhaps, midway between the two extremes since it is science in a more practical dress applied to industrial issues.

The scientific mind desires to enlarge the boundaries of human knowledge without reference to practical ends, the practical mind desires to achieve results in a particular and limited direction only.

The past separation between science and practice is to be deplored,—the scientist despising commercial gain, the practical man having experience is not overfond of abstruse theory unless directly applicable to a practical end. It is, however, certain that a more practical spirit in scientific research, together with more science in practice, would better serve industrial ends.

Despite Professor Marshall's dictum, practical knowledge is not altogether a hotch-potch of unrelated items of knowledge. It has taken a lot of first-class reasoning to elucidate why certain processes and methods have given practical results. Practice as often leads science as the reverse. A freer spirit of exchange and closer association which is now happily visible, is going to benefit industry in a marked manner. There is more understanding both sides than was previously the case.

PERSONALS

Capt. E. R. Taylor, R.E., '14 graduate of McGill, of Victoria, B.C., formerly engaged in civil engineering under the government, has been awarded the Military Cross.

John Hole, Sr., who for the past two years has been assistant superintendent of construction for the Toronto Harbor Commission, is leaving the commission to enter private practice as a general engineer and contractor.

Walter Baker Champ, who for many years has been secretary-treasurer of the Hamilton Bridge Works Co., Limited, and who was last week elected managing director and secretary of the company, was born in Hamilton, March 23rd, 1874. His entire business career has been with the Hamilton Bridge Works Co., having joined that firm when he was 17 years old. He was appointed treasurer of the company when only 24 years of age and seven years later he was made secretary-treasurer. Mr. Champ has been a director of the company since 1910. He is a member of the Hamilton Board of Trade and was president of that organization for the year 1909. He is a member of the Canadian Manufacturers' Association and served on the executive council of that association from 1909 to 1912. As managing-director of the Hamilton Bridge Works Co., Mr. Champ succeeds the late R. Maitland Roy, M.Can. Soc.C.E. Mr. Champ has been acting manager of the company since Mr. Roy's death in July, 1916.

British and Colonial Press Photo.

R. A. Sara addressed the Manitoba Branch of the Canadian Society of Civil Engineers last Tuesday evening on "The Statistical Methods and Equipment of the City of Winnipeg Light and Power Department." The meeting was held in the office of the City Light and Power Department and was followed by an inspection of the equipment in operation. The lecture was illustrated by lantern slides.

Edward S. Cole, president and treasurer of the Pitometer Co., was at a recent meeting of the New York Section of the American Water Works Association selected as a governor to take the place of Allan Hazen, who is retiring.

M. A. Black, C.E., a graduate of McGill University, recently with the Grand Trunk Railway at Windsor, Ont., has accepted a position as manager of the new concrete manufactures plant of J. J. McCaffrey, at South Devon, New Brunswick.

Howard Taylor, who for some years has been chief electrical and mechanical engineer of the Spanish River Pulp and Paper Co.'s plants, with headquarters at the Soo, has resigned to become consulting engineer with the Dayton-Wright Aeroplane Co., at Dayton, Ohio.

Gavin N. Houston, M.Can.Soc.C.E., formerly with the irrigation office, Department of Interior, at Calgary, has been appointed supervising engineer on the construction of the fifty-million-dollar explosives plant which the United States government is building at Charleston, West Virginia.

Lieut. Ronald Dare Gillespie, of the Imperial Gordon Highlanders, who was taken prisoner at La Bassee, January, 1915, has been exchanged and is in Holland. Lieut. Gillespie is a native of Victoria, B.C. He received his training in Edinburgh, Scotland, but returned to British Columbia to practise engineering and surveying.

ANNUAL MEETING OF JOINT COMMITTEE OF TECHNICAL ORGANIZATIONS

The second annual meeting of the joint committee of technical organizations will be held in the Chemistry and Mining Building, University of Toronto, March 25th, at 8 p.m.

The chairman's annual report will be presented, and Colonel David Carnegie will address the meeting on an important industrial problem.

Other speakers will be M. J. Butler, managing director of Armstrong-Whitworth, of Canada, Limited, and W. E. Segsworth, Administrator of the Vocational Branch, Military Hospitals Commission.

ASSOCIATION OF MUNICIPAL ELECTRICAL ENGINEERS

About one hundred of the managers, superintendents and engineers in charge of municipal electrical plants in Ontario met in Toronto March 13th and 14th.

For some time past it had been felt that in the best interests of all concerned it would be more desirable that instead of the organization remaining as an engineering section of the Ontario Municipal Electrical Association that a reorganization take place and a new association be formed of the managers, superintendents and engineers of the different municipal electric utilities free from the Ontario Municipal Electrical Association and financially independent.

E. V. Buchanan, of London, Ont., occupied the chair and after much discussion it was finally decided to go forward. It was moved by P. B. Yates, of St. Catharines, and seconded by O. M. Perry, Windsor, that the resolution looking to the new association be adopted. This was carried. The name of the new association is the Association of Municipal Electrical Engineers.

After a few minor amendments to the suggested constitution and by-laws the following officers were elected for the ensuing year: President, E. V. Buchanan, London; vice-president, E. I. Sifton, Hamilton; secretary, S. R. A. Clement, Hydro-Electric Power Commission, Toronto; treasurer, R. C. McCollum, Hydro-Electric Power Commission.

The following committees were also appointed: Membership and Credentials Committee, O. F. Scott, Belleville, chairman; Papers Committee, E. S. McIntyre, Kitchener, chairman; Convention Committee, W. J. Stapleton, Collingwood, chairman; Rules and Regulations Committee, R. H. Martindale, Sudbury, chairman.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Results of Test on Robert Simpson Building

Comparison Made With Flat Slab Codes—Simplicity of Construction, Economy in Story Heights, Unbroken Ceilings, Make Flat Slab Construction Popular

By

W. W. PEARSE
City Architect and Superintendent of Buildings, Toronto

PETER GILLESPIE, B.A.Sc.
Asso. Prof. Mechanical Engineering, University of Toronto

At the time the tests referred to in this article were made, Professor Gillespie kindly consented to help the Architects' Department in conducting a test which would prove whether the building was strong enough to carry the loads for which it was designed, and it was also thought that the tests would give additional information to the department so that it might be in a position to draft an up-to-date by-law covering flat slab type of construction.

Due to the cracks around the column capital, it was necessary, as shown in Fig. 6, to break the panel into strips, finding the moment of inertia of each strip and then adding them together. This, of course, would only give at best a very rough approximation, and, therefore, in considering these tests, due consideration must be given to this. I might also direct attention to the stresses given on Fig. 3-4, where it will be noticed, in a great many cases, that when the load is removed entirely, there still seems to be a larger stress in the steel and concrete than what was given by the first load of 135 pounds. This is shown in tables of stresses under columns I and 4. One explanation for this is that concrete has not the elastic nature that steel has but is more plastic, and, therefore, when the load is applied to the concrete, the concrete in compression is crushed and does not spring back to its original position. Another reason, no doubt, is due to the fact that, when the second load of 270 pounds was applied, bad cracks developed around the column capital head, thereby weakening the resisting value of the concrete in tension, so that even when all the loads were removed the original dead load would cause considerable stress in the steel and concrete due to the damaged condition of the concrete, therefore, when the final extensometer readings are taken the set of the concrete will be read by the instrument.

The deep cracks around the column heads are due to the steel work being set too low below the top of concrete. It will be noted by referring to Fig. 3, Col. 23, that the average distance below the top of the concrete to the steel is about 3½ inches. It is evident, therefore, that as soon as there is any tensile stress in the steel that there must be considerable tensile stress in the outside fibres of the concrete, and as this is only good for about 350 pounds to the square inch it would soon crack. From this test it would seem to the writer that either Chicago or Philadelphia codes, or the Report of the Joint Committee would give very safe and satisfactory results.

Professor Gillespie was assisted by Mr. R. J. Fuller and Mr. T. D. Mylrea, who were in the employ of this department at the time the tests were made, and Mr. W. A. McM Cook, of this department, assisted in compiling the results as given herewith.

W. W. PEARSE, City Architect and Superintendent of Buildings.

THE method of construction used in the Robt. Simpson Building, Toronto, is the four-way flat-slab drop-head reinforced concrete system known as "the four-way system."

Fig. 1 is a general plan of the building showing the area tested.

Figs. 2, 3 and 4 show the arrangement of the reinforcement, and the location of the points where the readings were taken and the stresses obtained.

The readings for a live load of 135 lbs. per square foot will be considered.

In comparing the stresses found by extensometer tests and those computed in accordance with the various building regulations the following notation will be used:—

L = distance c. to c. of column, in feet.
w = total live and dead load per square foot = 135 + 113 = 248 lbs.
W = total panel load in lbs. = wL^2.
s = tensile stress per square inch in steel.
c_t = extreme fibre tensile stress per sq. in. in concrete.
c = extreme fibre compressive stress per square inch in concrete.
I = moment of inertia.
Q_t = section modulus for side in tension.
Q_c = section modulus for side in compression.
E_s = modulus of elasticity of steel = 30,000,000.
E_c = modulus of elasticity of concrete in compression = 3,500,000.
E_t = modulus of elasticity of concrete in tension = 2,800,000 (assumed as $\frac{8}{10}E_c$ same as used for Wm. Davies Co. Building, Toronto).

Fig. 5 shows the strips into which the slab is considered to be divided for purposes of calculation.

Strip A at Edge of Capital

The stresses in strip A at the edge of the column capital will be considered first. The width of strip A will be taken as $\frac{L}{2}$, as assumed in the Chicago Code and Joint Committee Report.

In Fig. 6 the neutral axis, as obtained from deformations, has been plotted for readings Nos. 710, 713, 717, 601, 607 and 614, and its average position was found to be 9¼ ins. from the top of the slab, as indicated

In order to arrive at a rational method for determining the section moduli of the section, making due allowance for tension in the concrete, it was assumed that the tensile strength of concrete is 1/12th of its compressive strength (see "Materials of Construction," 4th edition, by J. B. Johnson, p. 604d) and thence was found the maximum deformation which could occur in the concrete without the formation of cracks.

The ultimate compressive strength of the concrete was found by test to be 3,900 pounds per square inch. Hence the ultimate tensile strength would be $\frac{3,900}{12}$ pounds per square inch = 325 pounds per square inch, and the corresponding deformation reading for live load, $325 \times \frac{40,000}{2,800,000} \times \frac{135}{248} = 2.5$ (see note at foot of Table 4), taking $E_t = \frac{8}{10}$, E_c = 2,800,000 for the concrete used.

The points in the cross-section at which this deformation occurred have been plotted in Fig. 6 and the concrete below the same was considered as effective cross-section in computing the moment of inertia and section moduli of the section. The upper inclined line in the figure marks the upper limit of this effective cross-section and the lower inclined line is drawn through the points obtained for the neutral axis for the three sets of readings mentioned above.

The effective section of concrete was divided into five rectangles, a, b, c, d and e. Figs. 6A, 6B, 6C, 6D and 6E show these rectangles with the positions of their respective neutral axes as obtained from Fig. 6.

The steel has been considered as replaced by its equivalent area of concrete assuming the moduli of elasticity of steel and concrete in tension to be 30,000,000 and 2,800,000 respectively. The moment of inertia of each rectangle and its proportionate area of steel was obtained and the results added to obtain the total moment of inertia for the section; using the average position of the neutral axis as 9¼ ins. from the top of slab the section moduli were then determined.

The results are as follows:—

$$I = 14{,}906$$
$$Q_c = 3{,}140$$
$$Q_t = 1{,}612$$

According to Chicago Code,

$$Mr = \frac{WL}{30} = \frac{125{,}000 \times 22.43 \times 12}{30} = 1{,}120{,}000 \text{ inch-pounds.}$$

$$\therefore \quad c = \frac{Mr}{Q_c} = -\frac{1{,}120{,}000}{3{,}140} = -357 \text{ pounds per sq. in.}$$

$$\text{and } c_t = \frac{Mr}{Q_t} = \frac{1{,}120{,}000}{1{,}012} = 695 \text{ pounds per sq. in.}$$

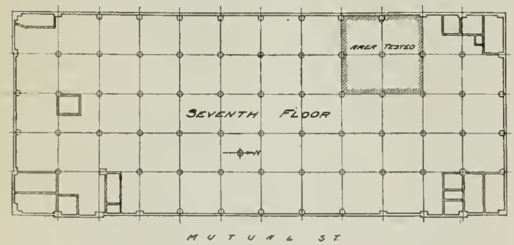

Fig. 1—Key Plan

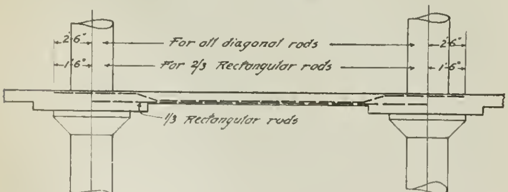

Fig. 2

The average of readings 601, 607 and 614 is —257 for live load only, which corresponds to a stress of $-257 \times \frac{248}{135} = -476$ pounds per sq. in. for live and dead load combined. This is somewhat greater than the value for c computed above.

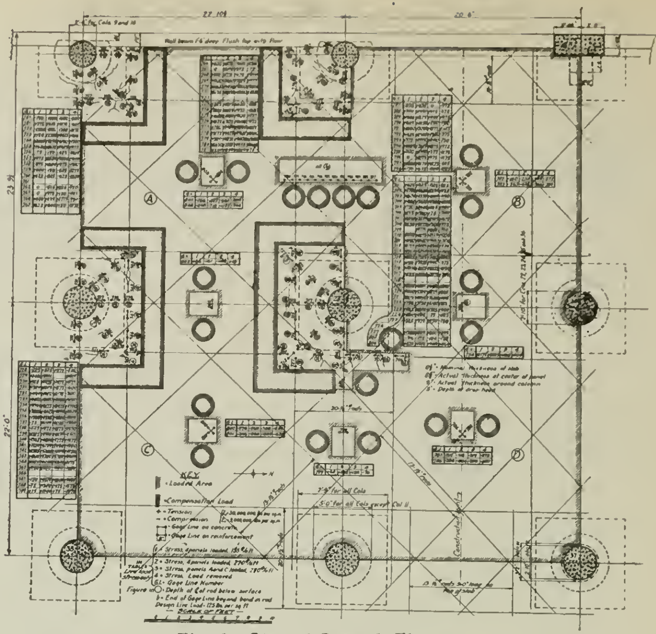

Fig. 3—Plan of Seventh Floor

Using the extreme fibre stress $c_t = 695$ pounds per square inch in the concrete as found above, the computed stress in the steel is found to be 5,020 pounds per sq. in.

The average of readings 710, 713 and 717 is 2,300 for live load only, which corresponds to a stress of $2{,}300 \times \frac{248}{135} = 4{,}230$ for live and dead load combined, which agrees very well with that computed.

The Philadelphia Code gives the bending moment as $\frac{WL}{28.4}$ ($\frac{WL}{47}$ for the steel in the straight band, and $\frac{WL}{72}$ for the steel in the diagonal band).

The Joint Committee Report gives the moment as $\frac{WL}{25}$.

The stresses computed by these moments for the readings mentioned above are given in Table 3. It will be noted that the distribution of steel at the column capital in the straight and diagonal bands differs considerably from that required by the Philadelphia Code, so that the table shows a high stress for the steel in the straight band and a comparatively low stress for the steel in the diagonal band at this point in the computation by the Philadelphia Code.

To find the moment coefficient which corresponds to the stresses computed from deformations given by test we may equate the bending moment to the resisting moment thus: $\frac{WL}{x} = Q_t\, c_t$ and $\frac{WL}{x'} = Q_c c$ where x and x' are the coefficients to be determined.

The average unit stress in the steel for total load as found above from readings 710, 713 and 717 was 4,230 pounds per square inch.

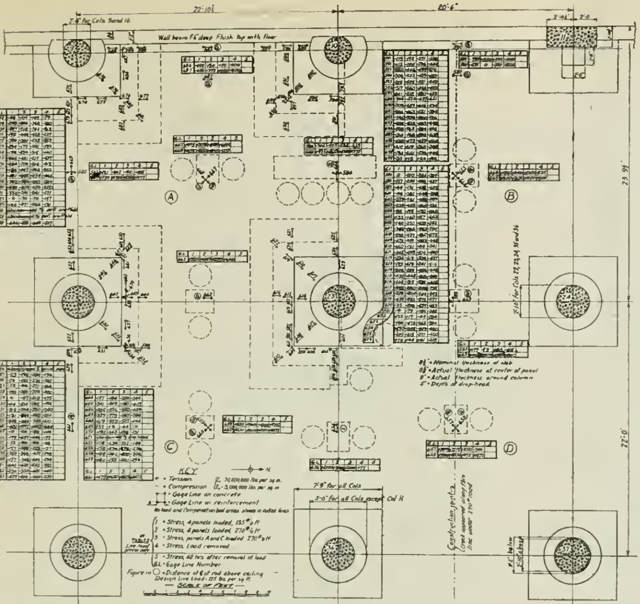

Fig. 4—Plan of Sixth Floor Ceiling

This corresponds to an extreme fibre stress in the concrete of $4,230 \times \frac{2,800,000}{30,000,000} \times \frac{9\frac{1}{4}}{6\frac{1}{4}} = 584$ pounds per square inch.

$$\therefore \quad \frac{125,000 \times 22.43 \times 12}{x} = 1,612 \times 584$$

whence $x = 36$.

The average extreme fibre stress in the concrete for total load as found above was — 476.

$$\therefore \quad \frac{125,000 \times 22.43 \times 12}{x'} = 3,140 \times 476$$

whence $x' = 22.6$.

The average of x and $x' = 29.3$ or, roughly, 30.

$\therefore$ the moment as found from test is $\frac{WL}{30}$, which agrees with the Chicago By-law and also very closely with the Philadelphia By-law.

Strip B at Centre of Panel

In Fig. 8 the position of the neutral axis has been determined as before from deformation readings 800, 801, 659 and 660, the average of readings 800 and 801 being 3.9 and the average of readings 659 and 660 being 1.35. The width of strip B has been taken as $\frac{L}{2}$ and the area of steel assumed according to the Chicago By-law.

Using the greater of the deformations found for the reinforcement, *viz.*, 1.6, it is found that the concrete below a point about 5⅝ in. from the lower surface is overstrained in tension. Therefore, only the concrete above this point has been considered as effective cross-section in computing the moment of inertia and section moduli of the section which follow:—

$$I = 7,195$$
$$Q_t = 2,620$$
$$Q_c = 1,410$$

According to Chicago By-law, $M_0 = \frac{WL}{120}$ = 280,000 inch-pounds.

$$\therefore \quad c_t = \frac{280,000}{2,620} = 106$$

$$\text{and } c = \frac{280,000}{1,410} = 200$$

Using the extreme fibre stress of 106 pounds per square inch in the concrete, the computed stress in the steel is $106 \times \frac{1^{13}/_{16}}{2\frac{3}{4}} \times \frac{30,000,000}{2,800,000} = 750$ pounds per square inch.

The average live load stress found from readings 659 and 660 is 1,012 pounds per square inch, which corresponds to a total stress of $1,012 \times \frac{246}{135} = 1,847$ pounds per square inch or more than twice that found by using the Chicago Code, taking into consideration tension in the concrete.

The average live load stress found from readings 800 and 801 is 341 pounds per square inch, which corresponds to a total stress of $341 \times \frac{246}{135} = 622$ pounds per square inch compression in extreme fibre of concrete, or more than three times that found by Chicago Code, taking into consideration the tension in the concrete.

The stresses computed by the other by-laws are given in Table 3.

To find the bending moment which corresponds to the stresses ascertained by test, we have as before $\frac{WL}{x} = Q_t c_t$ and $\frac{WL}{x'} = Q_c c$ where x and x' are the required coefficients.

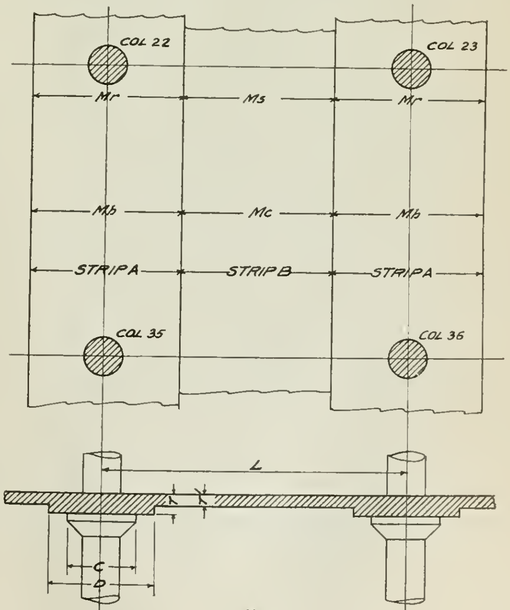

Fig. 5

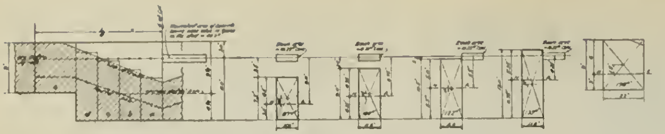

Fig. 6 Fig. 6A Fig. 6B Fig. 6C Fig. 6D Fig. 6E

Summarization of I's: Fig. 6A = 1,111; Fig. 6B = 1,177; Fig. 6C = 1,452; Fig. 6D = 1,933; Fig. 6E = 1,780.

The unit stress in the steel for the total load was 1,847 pounds per square inch, as found above.

This corresponds to a stress in the concrete at $2\frac{3}{4}$ ins. below the neutral axis of $1,847 \times \frac{2,800,000}{30,000,000} \times \frac{2\frac{3}{4}}{1\frac{13}{16}} = 262$.

$$\therefore \frac{125,000 \times 22.43 \times 12}{x} = 2,620 \times 262.$$

whence $x = 49$ or $M_o = \frac{WL}{49}$.

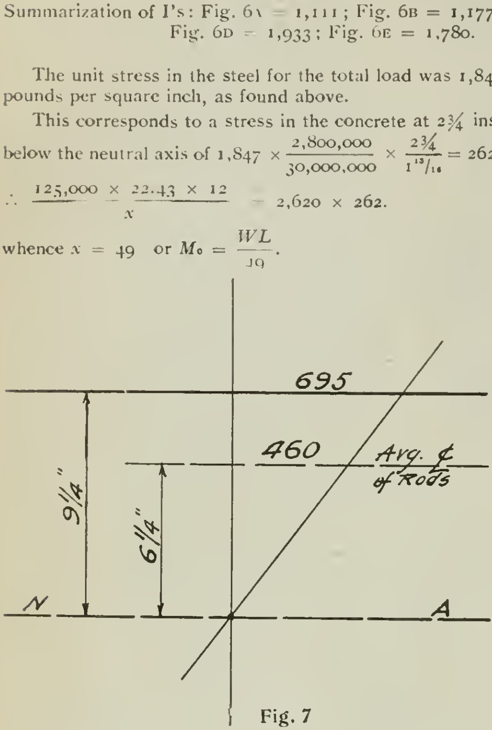

Fig. 7

Considering now the stress in the concrete, which was 622 pounds per square inch for total load, we have.

$$\frac{125,000 \times 22.43 \times 12}{x'} = 1,410 \times 622$$

whence we find $x' = 38.4$ or $M_o = \frac{WL}{38.4}$.

Taking the average of these two results, we have a moment of $\frac{1}{2}\left(\frac{WL}{49} + \frac{WL}{38.4}\right) = \frac{WL}{44}$ for strip B at centre.

Strip B at Centre Line of Columns

Fig. 9 shows a cross-section through strip B at the centre line of columns indicating the position of the neutral axis as determined from deformation readings.

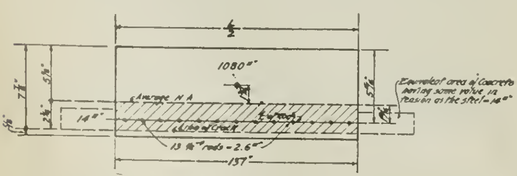

Fig. 8

$I = 7,195$ $Q_t = 2,620$ $Q_c = 1,410$

It was found in the same manner as before that a deformation of 2.5 for the live load would occur at 3.82 ins. above the neutral axis, so that only the concrete below this point could be considered effective. The properties of the section determined on this basis are:—

$$I = 4,102$$
$$Q_o = 1,346$$
$$Q_t = 876$$

The bending moment according to Chicago By-law is 236,000 inch-pounds.

$$\therefore c = \frac{236,000}{1,346} = 175\tfrac{1}{2} \text{ pounds per square inch.}$$

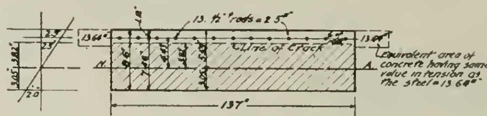

Fig. 9

$I = 4,102$ $Q_o = 1,346$ $Q_t = 876$

$$c_t = \frac{236,000}{876} = 270$$

and $s = 270 \times \frac{30,000,000}{2,800,000} = 2,890$ pounds per sq. in.

Readings 583 and 784 give $c = 319$ and $s = 3,960$ as the stresses for total load.

To find the bending moment coefficient corresponding to these readings we have

$$\frac{111,000 \times 21\frac{1}{4} \times 12}{x} = 876 \times 3,960 \times \frac{2,800,000}{30,000,000}$$

whence $x = 88$,

which gives $M_s = \frac{WL}{88}$ computed from stress in steel, also

$$\frac{111,000 \times 21\frac{1}{4} \times 12}{x'} = 1,346 \times 319$$

whence $x' = 66$

Code	Strip A	Strip B	Mr	Mb	Ms	Mc	C†	D†	T†	T'†
Chicago	$\frac{L}{2}$	$\frac{L}{2}$	$-\frac{WL}{30}$	$+\frac{WL}{80}$	$-\frac{WL}{120}$	$+\frac{WL}{120}$	.225L	.33L		6" or $\frac{L}{32}$
Philadelphia	$\frac{45}{100}L$	$\frac{45}{100}L$	$-\frac{WL}{28.4}$*	$+\frac{WL}{94}$	$-\frac{WL}{155}$	$+\frac{WL}{189}$	.2L	.38L	$1\frac{1}{3}T'$	
Joint Comm^te	$\frac{L}{2}$	$\frac{L}{2}$	$-\frac{WL}{25}$	$+\frac{WL}{55.5}$	$-\frac{WL}{100}$	$+\frac{WL}{133}$	.2L	.4L		6" or $\frac{L}{32}$

*Mr for steel in straight band is $\frac{WL}{44}$ and for steel in diagonal band $\frac{WL}{72}$.
†C, D, T, T', are minimum dimensions allowed by Codes.

Table 1—Comparison of Recommendations of Chicago and Philadelphia and Joint Committee Report

which gives $M_s = \frac{WL}{66}$ computed from stress in concrete, or an average of $M_s = \frac{WL}{77}$ for strip B at the centre line of columns.

	At edge of Capital						Strip A at Centre			Strip B at Centre								Strip B at ℄ of Cols	
Reading No.	710	713	717	601	607	614	656	662	663	657	658	659	660	785	786	800	801	784	583
Stress in	Steel	Steel	Steel	Conc	Conc	Conc	Steel	Steel	Steel	Steel	Steel	Steel	Steel	Conc	Conc	Conc	Conc	Steel	Conc
Chicago Code	15900	15040	15570	-658	-592	-635	18000	16080	16080	17680	16350	16350	17680	-326	-390	-326	-390	13270	-357
Philadelphia Code	[illegible]	[illegible]	[illegible]	-695	-626	-671	15310	13690	13690	14830	13610	13610	14830	-302	-361	-302	-361	10270	-307
Joint Comm^te Report	19600	18450	19100	-789	-710	-762	25950	23160	23160	11570	10530	10530	11500	-292	-352	-292	-352	15900	-428
Test	5925	4680	2066	-176	-676	-562	3860	6480	7720	7240	7110	1504	2190	-570	-717	-685	-557	3960	-319

Table 2—Comparison of Stresses for Live and Dead Loads Combined According to Various Codes, with Those Found by Test. Stresses are in Pounds Per Square Inch

Strip A at Centre

As there is no reading on the concrete for strip A at the centre, we cannot find the moment of inertia of this section.

By reference to Table 3 it will be noted that for the points of negative bending moment in strips A and B there is a fairly good agreement between the results obtained by test and those computed by the bending moments specified in the various codes, making allowance for tension in the concrete.

There is not a good agreement between the results obtained at the one point of positive bending moment for which readings were given so that I could be found.

	Strip A at edge of Capital		Strip A at Center	Strip B at centre				Strip B of Cols	
Reading Nº	710, 713, 717	601, 607, 614	656	657-8	659-660	785-6	800-1	784	583
Stress in	Steel	Concrete	Steel	Steel	Steel	Conc.	Conc.	Steel	Conc.
Chicago Code	5020	-357	855	750	750	-200	-200	2890	-176
Philadelphia Code	5300	-377	727	900	900	-185	-185	2240	-151
Joint Comm. Report	6150	-428	1231	483	483	-180	-180	3460	-210
Test	4230	-476	3860	7175	1847	-645	-622	3960	-319

Table 3—Comparison of Stresses for Live and Dead Loads Combined According to Various Codes, with Those Found by Test Using the Section Modulus Determined by Deformation Readings

This may possibly be partly due to the fact that the adjacent panels were not loaded, which would have the effect of increasing the positive moments in the loaded panels.

Moments which correspond to results found by test:—

$Mr = -\dfrac{WL}{29}$

Mb = (could not be determined).

$Mc = \dfrac{WL}{44}$ A large variation partly due, no doubt, to adjoining panels not being loaded.

$Ms = \dfrac{WL}{77}$

THE QUESTION OF UNBALANCED THRUST

By Peter Gillespie, M.Can.Soc.C.E.

NO other type of reinforced concrete construction has appealed to the building public or has caught the popular fancy as has that commonly described as the flat slab or girderless floor. The resulting economy in story heights, the simplified form construction, the unbroken ceilings and the ease with which auxiliary equipment as, for example, sprinkler systems, can be installed have all contributed to that popularity. But while these advantages have been generally recognized, the difficulties attending the rational design of flat slab structures have also been appreciated because this type does not lend itself to either simple or satisfactory theoretical treatment. Recognizing this, public-spirited firms and organizations have provided facilities whereby tests of full-size buildings have been made with a view to studying the behavior of floors under load and thereby formulating empirical rules for the design of flat slabs which, when constructed, would be safe without being wasteful. These tests have usually consisted in applying to the floor a live load equal to or exceeding that for which the structure was built and then measuring the deflections and the deformations in the steel and concrete at certain selected places in order to determine the intensity of the stress resulting. From the

Table 4—Extensometer Readings of Deformation Caused by Live Loads

Gage Line	135# on 4 panels	270# on 4 panels	270# on 2 panels	Load Removed	Gage Line	135# on 4 panels	270# on 4 panels	270# on 2 panels	Load Removed
580	±0.0	-2.4	-3.7	-3.7	650	-2.2	-2.8	-3.4	-1.5
581	-1.8	-2.9	-3.0	-5.0	651				
582	-0.5	-1.5	-3.2	-4.6	652	-1.3	-2.7	-3.8	-2.1
583	+2.0	-0.3	+1.0	-1.2	653	-1.8	-2.7	-4.3	-2.7
584	-3.5	-6.0	-6.1	-7.0	654	-2.1	-3.2	-4.8	-3.5
585	-1.5	-7.8	-4.7	-1.2	655	-1.6	-1.8	-3.2	-2.9
586	Cancelled	—	—	—	656	+2.8	+5.2	+4.0	+0.1
587	-0.6	-2.8	-3.2	-2.2	657	+5.3	+9.7	+15.1	-0.4
588	-0.3	-1.4	-2.7	-3.2	658	+5.2	+11.6	+1.3	+2.1
589	-1.0	+2.0	+0.3	-3.0	659	+1.1	+4.8	+5.6	+4.4
590	-0.9	0.0	-1.0	-3.1	660	+1.6	+4.8	+6.6	+3.3
591	-2.0	-2.2	-3.1	-4.6	661	+4.9	+2.2	+3.3	+3.3
592	-4.7	-10.7	-9.1	-6.9	662	+4.7	+19.5	+16.5	+8.8
593	-3.0	-5.1	-5.7	-5.9	663	+3.6	+18.1	+1.8	+1.6
594	-3.5	-3.8	-4.9	-4.9	664	+2.0	+11.2	+3.0	-1.5
595	-3.6	-6.0	-6.3	-6.2	665	+2.0	+10.2	+2.6	+1.1
596	-5.3	-6.4	-5.1	-7.1	666	+1.3	+7.5	+5.6	+1.7
597	-3.9	-2.5	-3.2	-5.7	667	+1.3	+12.1	+13.8	+8.0
598	-1.0	-1.2	-1.7	-0.9	668	+1.7	+7.8	+9.3	+5.7
599	-3.4	-7.4	-4.2	-3.2	669	+1.0	+3.1	+3.1	+1.7
600					670	-5.8	-8.2	-8.5	-7.0
601	-1.1	-4.4	-5.1	-5.8	671	-2.2	-3.0	-4.9	-2.6
602	-4.1	-8.7	-7.5	-6.5	672	-4.1	-4.0	-6.0	-4.1
603	-7.6	-5.2	-5.3	-6.1	673	-2.9	-2.0	-2.3	-2.2
604	-1.0	-2.0	-2.2	-4.7	674	-2.2	-2.7	-3.6	-1.6
605	+0.4	-1.6	-1.8	-3.0	675	-4.2	-5.5	-3.9	-5.0
606	-1.6	-4.0	-4.9	-6.2	676	-5.3	-8.1	-9.3	-4.7
607	-4.2	-9.9	-11.0	-8.0	677	-2.1	-2.0	-3.0	-3.0
608	-3.4	-5.0	-6.4	-5.4	678	-5.5	-12.4	-13.2	-7.6
609	-5.4	-10.5	-11.7	-7.4	679	-3.8	-6.7	-7.8	-3.7
610	-1.6	-1.5	-1.3	-3.9	680	-5.0	-6.9	-7.5	-4.0
611	-2.8	-5.7	-5.9	-5.6	681	-4.0	-3.9	-3.9	-3.1
612	-2.7	-2.5	-3.7	-5.0	682	-0.1	-0.8	-0.8	-1.8
613	-1.4	-2.5	-3.9	-5.9	683	-1.9	-3.1	-3.0	-1.5
614	-3.5	-6.5	-7.5	-7.4	684				
615	-7.2	-13.1	-13.9	-9.7	685				
616	-1.3	-3.6	-3.8	-4.6	686	-0.6	-0.7	-0.2	-1.2
617	-3.8	-11.2	-12.2	-8.4	687	-0.6	+1.5	+1.0	-0.0
618	-2.5	-6.9	-8.5	-6.2	688	-5.1	-5.7	-7.4	-5.8
619	-5.2	-9.5	-10.0	-6.6	689	-3.5	-4.8	-5.0	-7.1
620	-0.4	-3.4	-5.0	-5.2	690	-3.5	-4.1	-5.1	-6.1
621	-0.1	-0.9	-1.9	-4.4	691	-3.7	-5.5	-6.3	-4.5
622	+0.4	+0.2	-0.5	-3.7	692	-6.8	-10.7	-11.4	-8.3
623	-1.9	[illegible]	-3.9	-4.5	693	-5.3	-7.1	-7.8	-7.4
624	-6.0	-11.0	-9.7	-7.2	694	-6.5	-8.7	-10.1	-6.8
625	-1.2	-3.6	-3.1	-4.8	695	-7.1	-1.9	-3.4	-5.8
626	+0.8	+0.5	+0.7	-2.5	696	-4.9	-5.4	-5.2	-4.8
627	-0.6	-1.1	-3.1	-1.9	697	-2.4	-2.5	-4.2	-4.2
628	-2.2	-4.0	-4.3	-3.2	698	-2.2	-2.3	-2.7	-5.1
629	0.0	-1.8	-2.5	-2.0	699	-8.4	+0.2	+0.3	-2.2
630	-1.5	-2.1	-2.2	-2.7	701	+0.9	+1.1	-1.1	-1.1
631	-3.6	-4.5	-4.0	-4.0	702	+3.6	+6.2	+3.0	+1.5
632	-1.5	-8.5	-10.6	-4.0	703	+2.2	+3.4	+1.6	-1.4
633	-3.9	-5.3	-6.5	-2.4	704	+2.2	+4.9	+4.4	+2.5
634	-5.5	-11.4	-12.5	-5.3	705	+1.0	+3.2	+1.5	+1.2
635	-6.1	-0.3	-1.0	-1.7	706	+0.5	+2.0	+0.1	-1.2
636	-7.0	-5.0	-5.1	-2.0	707	+3.0	+4.7	+3.9	+2.1
637	-0.6	-1.1	-1.1	-1.0	708	+3.0	+4.1	+2.0	+0.5
638	-1.0	-3.3	-2.6	-1.8	709		+7.7	+1.6	-1.0
639	-4.0	-4.2	-5.2	-3.4	710	+4.3	+5.7	+3.1	+1.0
640	-1.8	-4.7	-4.9	-3.4	711	+1.4	+3.2	+1.2	+0.4
641	-2.8	-4.9	-6.2	-3.8	712	+2.9	+6.7	+6.0	+0.7
642	-2.7	-4.4	-5.5	-1.7	713	+3.4	+7.0	+7.1	+1.6
643	-3.0	-9.3	-11.4	-4.0	714	+6.3	+10.3	+9.9	+3.9
644	-4.0	-2.1	-3.3	-3.5	715	+0.2	+4.5	+1.2	-1.5
645	-3.9	-10.5	-10.4	-4.6	716	+3.0	+2.5	+4.5	-1.4
646	-3.2	-6.3	-7.8	-4.9	717	+1.5	+3.5	+5.3	+0.4
647	-4.1	-8.9	-9.9	-4.5	718				
648	-2.3	-4.1	-6.0	-3.0	719	+5.1	+9.1	+8.6	+3.6
721	+3.3	+8.3	+10.0	+1.9	764	+0.6	+0.7	+7.7	-1.0
722	+1.0	+5.4	+2.8	+0.5	765	+0.9	+0.8	+0.2	-4.5
723	+1.1	+3.4	+2.3	+1.2	766	+0.6	+1.7	-0.8	-3.1
724	+0.8	+1.5	-0.1	-1.5	767	0.0	+2.8	+0.5	-0.1
725	+0.7	+1.3	+1.0	-1.0	768	+0.4	+3.7	+0.9	+0.4
726					769	+2.0	+4.6	+4.5	+0.9
727	+1.8	+1.1	+0.4	+0.3	770	+5.6	+12.6	+12.4	+4.0
728	-0.3	+0.7	+1.3	-0.7	771	+2.9	+6.4	+6.0	+2.5
729	+3.2	+5.2		+5.1	772				
730	+3.7	+4.1	+3.3	+1.7	773	+0.7	+1.7	+0.6	-1.5
731	+1.0	+3.9	+2.1	-0.8	774	+1.8	+3.3	+1.3	-2.2
732	-1.4	+7.6	+2.9	-3.4	775	+2.2	+2.6	+1.2	+0.3
733	+4.6	+10.8	+11.0	+4.2	776	+1.7	+0.5	+2.7	-1.3
734	+3.2	+14.9	+11.3	+3.6	777	+1.0	+7.2	+3.8	+1.7
735	+5.1	+0.9	+9.0	+4.7	778	+6.9	+12.9	+7.9	+4.0
736	+2.0	+6.3	+6.0	-1.6	779	+2.0	+5.5	+4.4	+2.6
737	-0.1	+2.8	+2.7	-1.8	780	+3.0	+5.3	+3.3	+3.5
738	-0.7	+2.1	+2.5	-3.4	781	+1.6	+4.2	+2.2	+0.1
739	+3.1	+7.9	+8.5	-1.0	782	-1.6	-2.9	-2.2	-3.1
740	+3.1	+6.4	+7.7	+1.7	783	-3.0	-5.0	-3.5	-4.4
741	+5.0	+9.0	+9.4	+2.6	784	+2.9	+4.3	+1.9	+1.1
742	+3.9	+8.4	+8.9	+1.8	785	-3.6	-3.6	-3.6	-3.1
743	+5.6	+7.6	+7.6	+4.0	786	-4.3	-6.9	-4.3	-4.8
744	+3.4	+5.4	+8.4	+2.9	787	-0.3	+0.3	0.0	-1.3
745	-1.4	+1.0	-1.2	-1.4	788	+0.4	+3.0	+1.3	-0.5
746					789	+2.0	+2.1	+1.5	+1.3
747	-0.2	+6.1	+5.6	+4.3	790	+1.1	+1.7	+1.0	-1.0
748	-0.1	+1.8	+0.9	-2.1	791	+1.4	+4.1	+2.5	+0.7
749	+0.1	+1.6	+0.1	-2.1	792	[illegible]	+3.9	+1.8	-0.5
750	-1.0	-1.4	-1.4	-2.6	793	+0.5	+3.8	+1.4	-1.0
751	+0.5	+0.9	+1.7	-0.8	794	+2.7	+4.9	+2.5	+1.3
752	-2.0	-2.4	-1.8	-2.9	795	-0.4	+3.4	+0.5	-2.9
753	+0.2	+5.0	+5.9	+0.3	796	0.0	[illegible]	[illegible]	-2.1
754	+2.7	+7.0	+8.2	+2.6	797	+2.4	[illegible]	+1.7	-0.7
755	+2.2	+3.3	+4.9	+0.5	798	+0.2	+0.9	-0.8	-2.5
756	-0.1	-0.2	-0.7	-3.1	799	+0.7	+3.0	+1.4	-0.8
757	+1.3	+3.4	+4.0	+0.8	800	-4.3	-6.5	-7.0	-6.1
758	-0.3	+1.6	+1.3	-1.6	801	-3.3	-6.4	-6.9	-7.2
759	+0.8	-0.2	-0.7	-3.7	802	+0.3	-0.7	-1.7	+0.2
760	+0.7	-1.1	-0.9	-1.0	803	-1.9	-5.7	-7.6	-4.4
761					804	-2.6	-8.2	-13.2	-8.5
762	0.0	-0.7	+0.3	-1.0	805	-1.1	-2.0	-2.1	-1.8
763	+1.4	+1.3	+0.2	-1.5	806	+6.4	+13.4	+11.0	+5.3

+ = TENSION — = COMPRESSION

Note - Deformation readings are multiplied 5000 times. Also, the deformations are for a distance of 8 inches, so for actual unit deformations figures given should be divided by 40,000.

nature of the work some form of portable extensometer was necessary and for this, that known as the Berry strain gauge or some modification of it, has generally been used.

Any type of extensometer which has to be attached to a specimen and removed again between readings cannot possess the accuracy of measurement usually obtained from the stationary forms. Then, again, concrete is a material for which the ratio of stress to deformation is much more variable than it is for the metals. Moreover, for any given concrete and for all stresses above moderate working values, Hooke's law of proportionality between stress and strain does not obtain. Further, it is usually quite impossible to know at just what stage of the operation of loading, the concrete in tension will crack and throw upon the reinforcement the bulk if not all of the tension which it had been carrying. In consequence of these limitations it will be conceded that the figures obtained from the use of the portable extensometer, especially on concrete structures, must be interpreted in a broad and liberal manner and that they must not be considered as reflecting the last refinement of physical measurement. It should be noted, too, that the inevitable errors are probably relatively greater for small deformations than for large since the ratio of a probable error to a large deformation is less than to a small one.

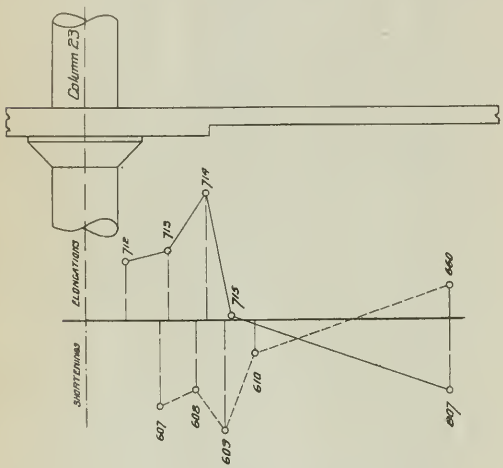

Fig. 10—Deformations in Steel and Concrete Graphically Shown

Top of slab shown thus ————————
Bottom of slab shown thus — — — — —

With respect to the Simpson Building test, there is one point to which attention might be called because it relates to a phenomenon which has been observed in several previous tests and is one which concerns the values to be assigned for the working stresses in both materials. To illustrate, Fig. 10 has been prepared from the test data. It will be seen that the various values of the observed deformations for the several gauge lines lying diagonally in one direction from column 23 have been plotted with respect to a horizontal axis, elongations upward and shortenings downward. Whether these relate to steel or concrete does not concern us, since it is to only one position on this radial line that attention is invited. Generally speaking, when either line crosses the horizontal axis, it denotes a point of zero deformation and therefore a point of zero flexural stress and of zero bending moment. If both lines cross the zero axis at the same point, it denotes a true point of contraflexure at which the stresses are mainly shears. In Fig. 10, however, this is not the case and for some distance outward from gauge line 715, the slab appears to be altogether in compression, and at gauge line 610; this, according to the records, is equal to an average stress of 70 pounds per square inch with a resultant acting much nearer the lower face than the upper. Moreover, in this particular region, the situation is not complicated by the presence of three or four superimposed layers of metal such as are found in some other places. This phenomenon is probably due to the partial behavior of the slab as an arch, an hypothesis, indeed, for which there is considerable warrant, since the peculiarity has been observed and reported on several occasions.

The city architect of Toronto, Mr. Pearse, is to be commended on the way in which he has planned these investigations and on the amount of profitable study which he has devoted to this problem of construction. All of the doubtful points have not been cleared up as yet, although much light has been thrown on many of them. As a result of careful and patient work by many investigators, the design of flat slab structures is to-day on a much more intelligent basis than it was five years ago.

WATERWORKS DEPT., CITY OF EDMONTON

A report just issued by City Commissioner A. G. Harrison, of the city of Edmonton, covering 1917, says that the waterworks department for the city enjoyed a surplus of $38,189.75. The total mileage of mains under pressure in the system at present is 164.8 miles. The total cost of water maintenance for the year amounted to $6,346.95, making an average cost of maintenance per mile, $38.70. During the year, 168 new water services were installed and 132 house sewer services. The total number of house services to date is 9,602 and the total number of water services 10,839. The average cost of maintenance per water service is 73 cents.

The growth of the system has been remarkable during the past ten years. In 1908, the city had 2,520 water services, 200 hydrants and 48.8 miles of water mains. In 1917, the number of water services had increased to 10,829 with 787 fire hydrants.

The number of water meters in use in the city is 7,700 and the average cost of maintenance per meter is 96½ cents.

The service given has been constant througrout the whole period and by regular daily tests the water supply is shown to be free from all contamination. One pound of liquid chlorine per million gallons was all that was found necessary, and proved to be far more economical than the old hypochloride of lime system.

The report of the Department of Public Works for the Province of British Columbia show an expenditure in 1916-17 of $48,754 in construction of roads and trails in the districts of Fernie, Greenwood, Kamloops, Kaslo, Revelstoke, Richmond, Similkameen, Skeena, Slocan, Yale and Ymir.

The iron work on the six new vessels to be built by the Lyall Shipbuilding Co., Vancouver, B.C., for their own use, will be manufactured in the shipbuilding yards by the company. Manager Cook is having installed under the superintendence of Supt. F. Davey, a large blacksmith shop, equipped with two steam hammers, furnaces and modern machinery for the carrying out of part of the ship construction.

THE GAS INDUSTRY AND CANADA'S FUEL PROBLEM*

By Arthur Hewitt
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THE condition which prevails in Canada to-day, with regard to the supply of fuel necessary for the maintenance of the industrial activity of the country, and for the domestic requirements of its population, demands a careful survey on the part of governmental authorities, and that every possible economy be exercised in order that the total requirements of fuel may be reduced to a minimum.

The fuels available for use in Canada may be generally stated as: coal, wood, petroleum, gas and water power electrically distributed. Each of these fuels has certain inherent advantages and their economic value is largely determined by the service to which they may be applied, and the localities in which they may be required.

In considering the economic value of various fuels on which Canada may rely to meet its domestic and industrial requirements, manufactured gas, or what is sometimes called "city" gas, must be given an important place. Originally used only as an illuminant, gas has become one of the vital necessities of the domestic and industrial life of urban communities throughout the civilized world.

In using the term "city" gas, I mean gas as ordinarily manufactured by gas companies, and distributed through pipe line systems laid beneath highways of cities and towns. In the early days of the industry, this commodity was called "coal" gas, for the reason that it was produced entirely from bituminous coal. The qualifying word "city" may be appropriately prefixed to the commodity as now supplied in recognition of the fact that economic considerations have caused different localities to combine with the coal gas, what is known as carburetted water gas. Indeed, in many cities on this continent carburetted water gas now forms the whole of the supply.

For practical purposes, however, there has been very little difference in the general character and useful properties of city gas during more than one hundred years.

The tremendous development and growth of the gas industry, particularly during the past ten years, furnishes abundant evidence of appreciation by the public, of the merits of the commodity supplied, and of the economy in the use of gas for the thousand and one purposes for which it is now so well adapted.

Its success in holding the market against all rivals of the same order of utility is due, largely, to its possession of certain valuable and unique physical properties, *viz.*:

(1) It is a permanent gas, suitable for consumption in or out of doors, either as an illuminant or as a smokeless fuel of high or low intensity, or as a source of motive power—all from the same supply system.

(2) It is susceptible of perfect sub-division without loss of efficiency for use in either required application for lighting or the production of heat or power. The cost to the consumer is always in direct proportion to the quantity consumed.

(3) It is a readily available fuel, cleanly and inoffensive, to be obtained by the turning of a tap, which will grill a chop, boil a kettle, or heat a flat iron, and there is no metallurgical or smith's work for which its heat is not adequate; no household warming for which it is not suitable. As a means of domestic cooking and heating, it is incidentally the practical cure for the smoke nuisance of towns.

*Abstracted from paper read before the first general professional meeting of the Canadian Society of Civil Engineers, held at Toronto March 26th and 27th, 1918.

City gas, as supplied in Toronto, is made by the distillation of Youghiogheny and Westmoreland coal, obtained in the Pittsburgh district, with the addition of about 40 per cent. of carburetted water gas.

At this point it might be interesting to see what a gas company can secure from a ton of bituminous coal.

In the first place, a ton of gas coal in an efficient carbonizing plant will yield ten thousand cubic feet of gas, from which may be extracted a certain percentage of benzene and toluol. It will produce approximately 1,350 lbs. of coke, from which, after providing the necessary fuel for the producers, there will be left a residue of from 800 to 850 lbs. of coke to be marketed as fuel for steam raising, industrial purposes and for domestic use. It will yield ten Imperial gallons of tar, from which may be recovered toluol, benzene, fuel oil, acids, dyes, etc. Another important by-product is ammonia, useful in the manufacture of fertilizer, and for refrigeration, and other purposes. There is also, as a minor by-product, retort carbon, which is used in the manufacture of carbon electrodes for search-lights, electrical steel furnaces, etc.

It is estimated that the percentage of efficiency obtained from coal, in a gas works, will run from 60 to 70 per cent. Compare this with the efficiency obtained in general practice from a ton of the same kind of coal used in an open fire which has just been fed with coal. Would the efficiency be 20 per cent. or less?

Let us make another comparison, and remember that the object of our discussion is to find the most economical way to use fuel, and especially coal.

The available supply of anthracite coal is admittedly limited, and the need for conservation is probably greater with regard to it, than is the case with any other kind of fuel. From every thousand tons of bituminous coal which a gas company carbonizes it produces and makes available for general consumption, as a substitute for anthracite coal, four hundred tons of gas house coke. The value of coke, as compared with anthracite coal, may be observed from the following analyses:—

	Anthracite coal.	Coke.
Moisture (after air drying)	3.20	1.60
Volatile combustible	6.86	8.27
Fixed carbon	76.61	76.23
Ash	13.33	13.90
Sulphur	.920	.942
Gross B.t.u. per lb.	12,800	12,200

Gas as Fuel for Industrial Purposes

A great deal has been said from time to time as to the unsanitary conditions of the atmosphere in our city, caused by the discharge of black smoke from chimneys. In spite of by-laws and the watchfulness of officials concerned with their enforcement, the evil seems to remain unabated, with every prospect of conditions becoming worse with the further growth of the city.

The problem of furnishing power, without making smoke, is rapidly being solved by the use of water power, distributed by electric lines. The use of coal in manufacturing processes, however, is still to be considered. Here the gas industry offers a means for the displacement of crude heating, which not only disestablishes the chimney as a polluter of the atmosphere, but introduces into the factory itself a controllable and uniform system of heating, producing constancy of result, and adding materially to industrial economy, by the reduction of labor, the promotion of cleanliness, and the speeding-up and improvement of factory output. These aspects of the case require the main part of our consideration, but without going into details we might well consider also the great destruction

of value for which the present crude methods of heating in factories are responsible. While gas can supply heat so easily controllable that there is comparatively little waste in obtaining from it effective duty, with coal there is necessarily a large waste of heat. There is a large amount of heat wasted in effecting its combustion, and in driving off those volatile constituents which are useless where high temperature and pure incandescence are required. There is also waste of heat up the chimney and through stand-by requirements. There is waste of heat every time a fire is re-charged until once more favorable working conditions of the fire are obtained. With the gas as fuel, the heat can be directed exactly as needed into the furnace, and heat losses by radiation and otherwise, can be reduced to a minimum.

I do not say that coal can be entirely displaced in factories; but I claim that a large part of it could be. The point I wish to make is, that in addition to air pollution, our industries are largely wasting, by their crude methods of heating, parts of the substance of the country which are necessary—more necessary to-day than they ever have been.

If these statements are correct, it can readily be seen how vast an opportunity there is to benefit the country at large, if we are able in any appreciable extent to do away with this waste. In case of any doubt as to the practicability of accomplishing this result, I believe that when it is seen how much has already been done in developing gas appliances to supplant the crude methods still so largely used, our knowledge of possibilities will lead us to believe that we see only the dawn of a new era in industrial heating.

The manufacturer has his point of view in this matter. It is not sufficient to explain to him how the use of gas will benefit the community; it is necessary to show him that it is to his direct benefit as a manufacturer, to adopt the modern methods of using heat in his processes. Some of these advantages are:—

(1) Economy in space occupied by appliance, and in some cases the necessity and expense of a smoke stack is avoided; a practically unlimited choice of position for the furnace, which enables it to be brought into close proximity to the machine workers.

(2) No space required for storage of fuel, and no removal of ashes.

(3) Increase in output per cubic foot of factory space, owing to economy of space occupied by gas furnaces in comparison with coal furnaces.

(4) The constant and unvarying supply of fuel, of a uniform heat value, at a fixed rate.

(5) Labor saving—absence of stoking, storage and conveyance of fuel.

(6) Rapidity, and improved production, due to ability to precisely control working temperatures.

(7) In many cases a lower capital expenditure for installation.

(8) Cleanliness, which frequently assists in decreasing net labor cost.

(9) No interest to be paid on investment in fuel in storage.

(10) Reduced fire risk.

(11) No loss of material due to inability to check a high temperature instantaneously.

(12) Less repairs on equipment.

(13) Enormously smaller loss from articles or materials being spoiled by irregular heat.

When these points are taken into consideration, it is really astonishing how many instances there are where the total cost of manufacturing is less with gas than with coal.

The Use of Gas in the Manufacture of Munitions

The same causes which make gas valuable for ordinary industrial purposes apply with increased force to the manufacture of munitions. In England it is publicly admitted that the tremendous leap forward in munition manufacturing could not have been made without the use of gas. On this side of the water, while the need for gas was not vital, nevertheless gas has played an increasingly important part in munition making. At times it has been adapted solely because of the speed with which an installation could be made, but once in, it stays in, when the intrinsic merits of the fuel become known.

When munitions are mentioned, we naturally think of shells, and it is in the manufacture of shells that much of the gas used in munition works has been consumed.

In the manufacture of shrapnel, every shell has to be hardened and tempered in a manner similar to the treatment of tool steel. The end of the shell must also be heated in order to forge in the end, or "nose" it. Much gas has been used for this purpose, and also for heating water used for washing grease off the finished shell, and for melting rosin which is poured into the shell after it has been charged with bullets. Even the high explosive shells have required gas. It has been used in ovens for baking varnish on the inside of the shell and in some sizes, notably the six-inch, large quantities have been used in forges for "nosing in."

Comparatively large gas-fired annealing furnaces have been employed for the treatment of various parts of shells, rifles, etc. Many parts are heated in forges for various operations, some of these forges being even 25 or 30 feet high, which shows that gas is being worked into the heavier operations.

Although large quantities of gas have been used for the purposes to which I have referred, it is not contended that other fuels could not be used, but nevertheless for various reasons, gas has been preferred. In the manufacture of small cartridge cases, however, gas is almost a necessity, and to the best of our knowledge is the only fuel used in the intricate machines which turn out millions of small cases, every one of which must be treated with absolute uniformity.

Continuity of Gas Supply in Toronto

Gas was first supplied in Toronto on the 28th of December, 1841, and from careful investigation it would appear that, while there have been local stoppages due to frost, broken mains, etc., there has not been even a momentary interruption to the general gas supply to the city since that date, a period of more than seventy-six years.

Conclusion

I shall have failed in the purpose of this paper if I do not state definitely my conviction that each class of fuel available for consumption in Canada should be selected and appropriated for the purposes for which it is inherently and economically best suited, regard being had to the essential objectives of:—

(1) Limiting the necessity for importing fuel from other countries.

(2) Limiting as far as possible the use of high-grade gas coal, to the purposes for which the largest percentage of its efficiency can be usefully employed.

(3) Avoiding the use of fuel requiring a long haul wherever it is possible to secure a suitable substitute requiring only a short haul.

CONCRETE PAVED BANK REVETMENT*

By G. C. Haydon, M.Am.Soc.C.E.
Assistant Engineer, Missouri River Improvement Scheme.

IMPROVEMENT of the Missouri River by the United States government, by means of works designed for the contraction of channel widths and bank protection, began as early as 1876.

The successful protection of caving banks is the foundation of the improvement of the river, and has been the great study to those engaged on the work. This study, combined with trials and experiments with many types of work, resulted in the evolution of what is known as "Standard Revetment" . . . This consists of a continuous woven willow brush mattress ballasted to cover the bank below the water line and, on the river bed, for protection of the subaqueous bank, the upper sloped bank being covered with a rough pavement of one-man riprap stone. It has generally been found that, from the use of this type fair results have been obtained, due, perhaps, to the fact that it readily adjusts itself to any disturbance of its foundation which may reduce the extent of the disturbance, and because it lends itself to repair which can

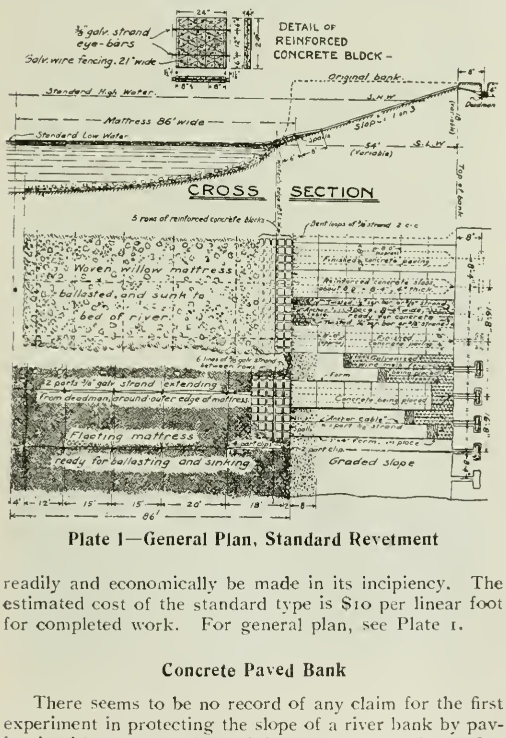

Plate 1—General Plan, Standard Revetment

readily and economically be made in its incipiency. The estimated cost of the standard type is $10 per linear foot for completed work. For general plan, see Plate 1.

Concrete Paved Bank

There seems to be no record of any claim for the first experiment in protecting the slope of a river bank by paving it with concrete, although it was used as early as 1897 in protecting the toe of the slope for the Holland dikes, and in 1900 by the Corps of Engineers, U.S. Army, for the upper bank paving in river improvements.

This type is somewhat like a monolithic structure and tends to lose the advantage of automatic adjustment to slight changes in the foundation, so that there is a constant uncertainty as to its condition and a possibility of a serious collapse in after years.

This revetment is a departure from the standard type used on the Missouri River in that the upper bank is paved with a 4-inch layer of reinforced concrete slabs instead of broken stone, and the subaqueous willow mattress pro-

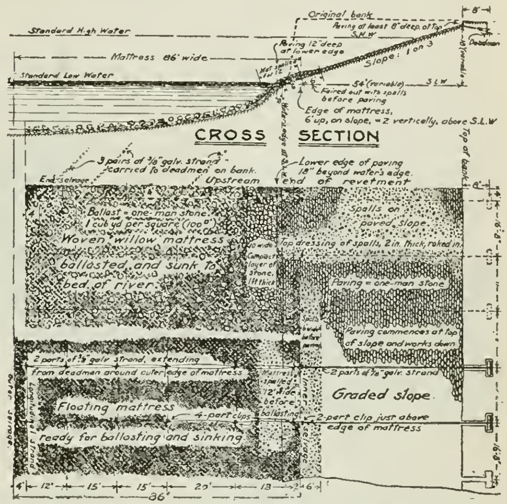

Plate 2—General Plan, Combination Concrete and Willow Mattress Revetment

tected for about 10 feet width from the shore edge, with reinforced concrete blocks connected to the solid upper pavement, and so laced and tied together with wire strand within themselves as to form a flexible covering instead of the compact layer of stone for the same width. For the general plan, see Plate 2.

The concrete paved bank revetment, selected for description, is known as the Bates Island Bend revetment, located on the right bank of the river at mile 98, above the mouth.

It was the first piece, of any magnitude, constructed on the river in which machinery and a system of organization for progress was used, and comprises 14,188 feet of finished work at $7.58 per linear foot. It was begun in March, 1912, and completed September 8th, 1913, by hired labor and government plant.

Plant

The plant used on the work consisted of the following: One double-decked quarterboat with a capacity of housing from 60 to 70 laborers and necessary foremen, 1 hydraulic grader, 1 mattress barge, 1 barge for concrete mixer plant, 6 material barges, and 1 tow boat. The working plant was supplemented by an 8-inch suction pump, installed on a material barge, for procuring gravel. The value of this plant is estimated at $60,000, no charges having been made for depreciation.

Material

The principal material used, which was procured locally and delivered by barge, consisted of willow brush at $1.60 per cord; stone at $0.68 per cubic yard, and sand and gravel at $0.08 per cubic yard; manufactured material delivered by freight consisted of 3/8-inch galvanized strand at $0.71 per linear foot; 50-inch galvanized woven-

*"Professional Memoirs."

fence wire, for the paving, at \$0.06 per linear foot; 22-inch fence wire, for blocks, at \$0.03 per linear foot; lumber, for forms, at \$22 per M. b.m., and Portland cement at \$0.75 per bbl. (f.o.b. factory). The gravel for the concrete paving and blocks was procured from the Gasconade River about 2 miles above the mouth, and delivered on barges by an 8-inch suction pump. It is a natural mixture of clean sand and gravel, the latter rang-

Fig. 1—Typical Concave Bank

ing in size from a ¼-inch to 3-inch pebble; it was impracticable to keep an itemized cost of procuring this gravel as it was in conjunction with other items of construction.

The cement used was of the American Portland brand. The finished aggregate is of a 1:2:4 mixture.

The ⅜-inch diameter galvanized strand is composed of seven No. 11 wires, having a tensile strength of about 5,000 pounds.

The reinforcing for the paving consists of galvanized woven-wire fabric, diamond mesh 50 inches wide, formed of thirteen No. 10-gauge line wires uniformly spaced, with No. 12½-gauge stay wires at 4-inch intervals; elastic limit 75,000 pounds to the square inch. In addition to the woven-wire fabric, and the mattress ⅜-inch anchor strands, similar strands for block fastenings are spaced 16⅔ feet, which gives a ⅜-inch strand reinforcing every 8⅓ feet, in the slab, anchored to a deadman on top bank.

The reinforcing for the concrete blocks consists of 22-inch woven-wire fabric, similar to that used in the paving. In addition to the woven fabric, two ⅜-inch strands are placed with an "eye loop" at each end for joining the blocks. These blocks, 2 ft. x 2 ft. x 4 ins., were made at a central yard at a cost of 28 cents each, and delivered by barge at site of the work.

In the construction of revetment the work is practically divided into three general classes: First, grading; second, mattressing; and third, paving. In the matter of cost accounting, the two latter classes are subdivided into the necessary heads for determining the expenditures of procuring, delivering, and placing the material. As these are usually variable quantities fixed by accessibility and the law of supply and demand, these detailed headings will be omitted. For a typical concave bank, see Fig. 1.

Grading

The bank is graded by the hydraulic method to 1 on 3, which gives a length of slope from 42 to 54 feet according to height above standard low water, which also determines the length of a slab. (Fig. 2.)

Mattress

After the bank is graded the continuous mattress, 86 feet wide, is woven of bar-growth willows, from ½ to 2 inches in diameter at the butt end and 10 to 25 feet long. The header, about 12 inches in diameter, is formed by lapped bundles of willows bound together to the desired width of mattress, by ⅜-inch strand. The stitch is then started by inserting single willows into the bundle at an angle of about 45 degrees, from one end of the header to the other; then the willows are inserted at the same angle in the reverse direction, the last willow inserted being on top (Fig. 3). This makes the weaving a continuous over process, the stitch having an over and under appearance. The willows are placed in such numbers and closeness of weave as to make a mattress 12 inches thick. As the weaving progresses a selvage is made along each side of the mattress by turning in the tops of the outer willows, or an equally good selvage (known as the "sidewalk") is made by platting willows, longitudinally along the edges.

The mattress is strengthened by a longitudinal and cross system of ⅜-inch in diameter galvanized strand. The longitudinal system for an 86-foot mattress consists of 6 pairs of strands, spaced as required, each pair consisting of 1 strand underneath and 1 strand on top of the mattress. The cross systems are in pairs, one underneath and one on top, spaced 16⅔ feet apart. At each intersection of the two strands underneath and the two strands on top, all four are drawn together tightly with a 7/16-inch U-shaped clip, after all the slack has been taken out of the strands by block and tackle. The head of the continuous mattress, or any section of mattress, is anchored by three pairs of strands fastened to the respective longitudinal strands, one pair 4 feet, one pair 16 feet, and the remaining pair 46 feet back from the outer corner and run ashore at a 45° angle with the upper edge of the mattress and fastened to deadmen 50 feet back from the edge of the bank. The continuous mattress is anchored to the bank

Fig. 2—Hydraulic Grading of Bank; Slope 1 on 3

by each pair of cross strands carried up the slope and fastened to a deadman placed 8 feet back, and 4 feet below the top of slope.

It was planned to string the concrete blocks, forming the 10-foot width inshore mattress flexible protection, on six longitudinal ⅜-inch strands passed through the eye loops, but this method was found difficult and slow. A change was made for connection of the inside blocks by using short pieces of ⅜-inch strand passed through the

eye loops and twisted into a clip. The changed plan required only four longitudinal strands; the two outside ones passed through the eye loops, the upper one serving to anchor the blocks to the paving, and the lower one to lock the system or hold the blocks *en masse*; the two inside strands laid along alternate joints are held in place by the twisted clips. The blocks are laid as close as possible, longitudinally, with no ties between. On account of the weight of the blocks, it was necessary to place them in advance of the paving and ballasting of the mattress and well up to the mattress barge and later anchored them to the paving.

Fig. 3—Header for Willow Brush Mattress; Starting Stitch

In this way they also serve as the lower forming for the concrete slab. (Fig. 4.)

The mattress is then ballasted with one-man stone of sufficient quantity to cause it to be in good contact with and take the shape of the river bed, and to allow the mixing plant to come near the toe of slope.

Paving

After the bank is graded, and mattress woven and ballasted in place, the slope is prepared for the concrete paving. It is divided into panels 8 feet wide, from top of bank to water surface, by placing a forming of 1-in. x 4-in. plank on edge, held in place by small wooden pegs, the inside pegs being removed as the aggregate is placed; the panel is then divided into 8-foot sections by placing ordinary plastering laths across the panel, or longitudinally with the bank under the mattress and block anchor strands; this forming makes the joints of the slabs. At the foot of the paving additional short pieces of ⅜-inch strand are so placed as to provide the required number of fastenings for the 2-foot blocks. The reinforcing wire mesh is then laid in place by unrolling the bundle from top to bottom of slope and held in place by pegs (which are removed as the aggregate is placed), two widths to the panel, each overlapping about 3 inches along the middle line and cut off at the bottom to the required length.

The concrete mixer and delivery plant were installed on a barge, 30 ft. x 80 ft. x 4 ft. (mattress barge). The mixer was a standard make on skids; the delivery plant or cableway, consisted of a regulation 3-drum hoisting machine and stiff-leg braced mast, with top sheave for the hoisting cable carrying the mortar bucket. For convenience in moving and to procure the proper land height the carrying end of the cable was passed over a wooden horse about 8 feet high. The mast and mixer were so placed that the bucket could easily pass to and from the discharge spout.

After the bucket was filled it was raised to proper height and travelled ashore by gravity; a reverse operation returned the bucket to the mixer. A movable stop block on the cable, held by dogs, marked the place desired, and a trip on the running sheave of the bucket coming in contact with the block automatically deposited the aggregate of the slope. (Fig. 5.) The method of depositing the aggregate as described above was later changed to the use of governing cables connected to the bail of the bucket, with a trip, worked by hand, to tilt the bucket. After experimenting for cable anchorage the following was evolved and proved very satisfactory: The carrying cable, after passing over the horse, was connected with a sheave and shackle so as to run in the bight of a double cable, about 350 feet long, running parallel to the bank and anchored to deadmen at each end. Two of these cables were provided, and when placed, were laid with the ends overlapping about 50 feet, so that the arrangement carrying the sheave could be run from the end of one cable direct to the other without delaying the work. The cable behind would then be carried forward and placed ahead of the one in use and so on continuously. These cables were found to carry the strain without danger and were especially advantageous for allowing ready movement forward or backward from one slab to the next. The deposit of the aggregate on the slope began at the top, which always gave a downward movement of the material. No attempt was made to give a finished surface other than that produced by a 2-in. x 4-in. scantling in evening up the aggregate to the required thickness after the necessary spade spreading. Before the final set occurs the top of the longitudinal joint is made, by a roller cutter, through the concrete down to the top of the lath (the lath being left in place).

The slope is paved in alternate panels; that is, if the panels should be numbered 1, 2, 3, 4, 5, 6, 7, etc., panels

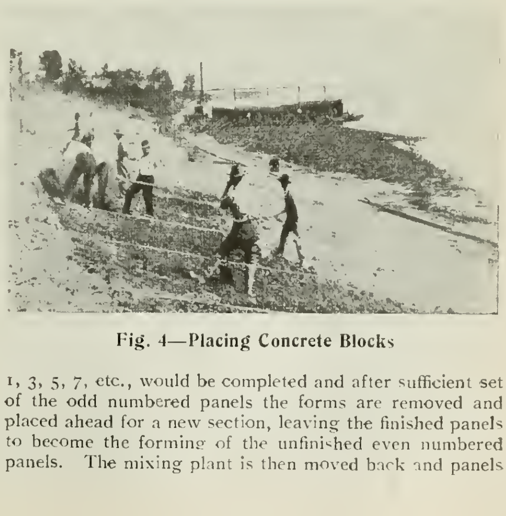

Fig. 4—Placing Concrete Blocks

1, 3, 5, 7, etc., would be completed and after sufficient set of the odd numbered panels the forms are removed and placed ahead for a new section, leaving the finished panels to become the forming of the unfinished even numbered panels. The mixing plant is then moved back and panels

2, 4, 6, etc., are completed, and so on until the completion of the work. (Fig. 5.)

About one-half of the work at Bates Island Bend was completed during the season of 1912, at which time it was not thought necessary to make provision for expansion joints, but during the hot weather of 1913, the necessity of expansion joints became evident when several of the slabs buckled up at the joints. In all cases where the slabs had buckled, which occurred at about 1,000-foot intervals, the joints were cut to let the slabs resume their natural position; because of this defect the remainder of the revetment was provided with ½-inch expansion joints every 50 feet to allow the slabs to expand or contract lengthwise of the revetment.

Fig. 5—Concrete Mixer and Delivery Plant; Also Completed Section of Paving

Cost

As stated above no charge for plant depreciation has been entered into the cost of the revetment, but from the field cost as shown, a liberal percentage of cost of plant depreciation can be added and the total for this type will be under that of the standard type. The statement given below contains only field expenditures with the cost divided as follows:—

Grading bank	$0.55	per lin. ft.
Weaving mattress	1.98	" " "
Concrete blocks in place	1.16	" " "
Ballasting mattress	1.13	" " "
Concrete paving	2.76	" " "
Total	$7.58	per lin. ft.

As two other pieces of this type of revetment have since been completed under similar conditions, their costs are given here for general comparison, and, to a certain extent, permit the establishment of a proper basis for estimates.

Marthasville Bend: 11,960 feet at $8.05 per linear foot, completed November 25th, 1914.

The cost is divided as follows:—

Grading bank	$0.84	per lin. ft.
Weaving mattress	1.85	" " "
Concrete blocks in place	1.56	" " "
Ballasting mattress	.83	" " "
Concrete paving	2.97	" " "
Total	$8.05	per lin. ft.

Dewey Bend: 7,215 feet at $88.13 per linear foot, completed December 17th, 1915.

The cost is divided as follows:—

Grading bank	$0.67	per lin. ft.
Weaving mattress	2.31	" " "
Concrete blocks in place	1.45	" " "
Ballasting mattress	1.22	" " "
Concrete paving	2.48	" " "
Total	$8.13	per lin. ft.

Failures

Before the work at Bates Island Bend was completed one break occurred where the paving was undermined, and the slabs broken in a diagonal line, down stream from the water surface to about 15 feet up the slope, over a length of about 100 feet. The exact cause of the break could not be determined, for, as nearly as could be ascertained by soundings the mattress and blocks seemed to be intact and later investigations confirm this fact. The break was located in a strong eddy (produced by a submerged false point which was not known to exist at time of construction), and the nature of the soil in the bank, fine sand, below the eddy was very unstable, which may account for the bank sliding or being sucked out between the interstices of the mattress. This break was successfully repaired with a brush and stone fill to fair out the bight and break up the eddy.

The revetment withstood the high stage of 1914, only to be battered and damaged during the continued high stages of 1915. This failure was described in the Annual Report of the Chief of Engineers, 1916, as follows: "This revetment (Bates Island Bend) was badly damaged at intervals, for a distance of about 6,000 feet from the lower end; so far, a satisfactory reason for this damage has not been determined, as much of the paved bank with mattress and concrete blocks is intact at toe of slope, the breaks being mostly in the paving, 8 feet above the low-water line, where the slabs, with reinforcing strand and wire are broken in every conceivable manner and shape, the strand and wire being sheared off as though with a knife. At low water, about 1,000 feet of this revetment from the lower end, shows up with the bottom row of 8-foot paving slab intact, with a pocket of water 6 to 8 feet deep behind the line. The breaks in this revetment, except the 1,000 feet at lower end, were repaired with brush and stone fills to fair out the slope line, in all 2,956 linear feet."

Sufficient time has not elapsed to pass on the positive merits of the monolithic type, nor do the failures noted seem of such seriousness as to warrant its discontinuance, but from the many methods of slope paving and subaqueous bank protection still in the experimental stage, the problem seems to remain unsolved, and because of this, there will be no attempt made to forecast the values of any type of bank protection, as the number of unknown forces constantly in operation toward deterioration precludes any prediction of permanency.

Grant Hall, vice-president and general manager of the Canadian Pacific Railway's western lines, was waited upon at Regina recently by the Hon. Charles Dunning, provincial treasurer and director of food productions, Alberta; J. A. Maharg, M.P., president of the Saskatchewan Grain Growers' Association, and George Spence, M.L.A., for Notukeu, representing a provisional railroad organization in the southwestern part of the province with reference to the construction of branch lines in the south western parts of the province.

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BOOK REVIEWS

Hydro-Electric Power Stations

By David B. Rushmore and Eric A. Lof. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1917. 822 pages, 408 illustrations, 6 x 9 ins., cloth. Price, $6 net.

This treatise deals with the problems of design and operation of hydro-electric power stations. The chapters in their order are entitled: General Introduction, Hydrology, Classification of Development, Dams and Headworks, Water Conductors and Accessories; Storage Reservoirs, Power House Design, Hydraulic Equipment, Electrical Equipment, Economical Aspects, Organization and Operation, Three Appendices.

In such a book it is impossible to do more than direct the reader's attention to the essentials of proper and adequate design of power stations. The authors in this case have succeeded in indicating with clearness and conciseness, yet with sufficient detail, the primary requisites of modern, well-balanced design, and by means of references to current technical literature have shown where detailed information on special points may be found.

A glance over this book may lead the reader to infer that certain parts, particularly the hydraulic features, are treated in a cursory manner. This impression, however, is not sustained after a careful reading, as all the works appurtenant to any development are treated in sufficient detail to give correct methods. With the references mentioned above, the student should have no difficulty in advancing his knowledge of the subject.

The part of the book covering the electrical equipment describes modern practice and devotes considerable space to the application of current limiting reactors and to the rupturing capacities of oil switches.

Considerable space is devoted to a discussion of the economical aspects of developments, also to the operation and maintenance of plants.

The three appendices give a fairly complete list of references to articles in the engineering press describing large power developments in America, and a table gives the principal data on transmission systems operating at 70,000 volts and above.

This volume should prove valuable both to the student of hydro-electric engineering and to the operating engineer.

Estate Economics

By Andrew Slater, late land agent to the War Department in the Southern, Northern and Scottish Commands. Published by Constable & Co., Limited, London. 264 pages, 87 illustrations, 5½ x 8¾ ins., cloth. Price, $2.50 net. (Reviewed by H. L. Seymour, B.A.Sc., A.M.Can.Soc.C.E., Ottawa.)

As applied to towns and cities the term "town planning" is now well known if not always well understood. The equally important problem of rural planning is also beginning to receive some share of attention. In general, it may be stated that the number of Canadian engineers who are interested in the scientific laying-out and development of land is on the increase. To such engineers Mr. Slater's work may make an appeal, though it treats entirely of estate or farm development in Great Britain.

To any engineer a consideration of the subject matter of the various chapters must indicate how useful a wide engineering knowledge may prove in rural development. In what might appear to many an elementary way, the author treats of many subjects with which engineers are more or less familiar; of the geology of soils, their origin and drainage; of the protection of the banks of water courses; of road construction and maintenance; of water supply ad sewage; of motive power produced by natural and artificial means; of motor traction; of forestry; of farm buildings, fences, etc.

From the standpoint of greater production, which the author urges in his introduction, probably the most important chapter in the book is that entitled "The Utilization of Land." This chapter might seem to apply most particularly to those classes of British land owners, land agents and factors for whom the author hopes to provide a practical guide, but even here will be found several matters more or less of interest to engineers.

A Treatise on Concrete, Plain and Reinforced

By F. W. Taylor and S. E. Thompson. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. Third edition, 1916. 885 pages, 262 figures, 6 x 9 ins., cloth. Price, $5 net. (Reviewed by E. Brydone-Jack, superintending engineer, Manitoba, Saskatchewan and Alberta, Department of Public Works, Canada.)

The third edition of this standard work has been brought up to date by its authors. Much new material on design and tests of reinforced concrete and on beam bridges has been added and the old edition has been largely rewritten and revised, to bring the subject up to date, while the most recent and accepted standard specifications for cement and reinforced concrete are given.

The main features dealt with in this edition may be classified as follows:—

Materials: Classification of cement, Chap. 4; chemistry of cement, Chap. 5; specifications and tests of cement, Chap. 6; tests of aggregates, Chap. 7; voids and other characteristics of concrete aggregates, Chap. 8; cement manufacture, Chap. 31; specifications for reinforced concrete, Chap. 3.

Proportioning of Materials and Strength: Strength and composition of cement mortars, Chap. 9; proportioning concrete, Chap. 10; tables of quantities of materials for concrete and mortar, Chap. 11; strength of plain concrete, Chap. 19.

Workmanship: Elementary outline of the process of concreting, Chap. 2; preparation of materials for concrete, Chap. 12; mixing concrete, Chap. 13; depositing concrete, Chap. 14; laying concrete in freezing weather, Chap. 16.

Destructive Agencies: Effect of sea water upon concrete and mortar, Chap. 15; destructive agencies, Chap. 17.

Theory, Design and Tests of Reinforced Concrete: Theory, Chap. 20; design, Chap. 22; tests, Chap. 21.

Construction: Foundations and piers, Chap. 24; dams and retaining walls, Chap. 27; conduits and tunnels, Chap. 28; reservoirs and tanks, Chap. 29; pavements and sidewalks, Chap. 30; beam bridges, Chap. 25; arches, Chap. 26; buildings, Chap. 23; miscellaneous structures, Chap. 32.

A special chapter is devoted to the subject of watertightness and the laws and tests of permeability.

Chap. 1 is devoted to a summary of the most essential elements in concrete construction. The essential elements are clearly stated and emphasized in heavy type and form an extremely valuable guide for the main principles required to ensure good workmanship and proper design.

The principal conclusions of the effect of sea water upon concrete and mortar, as reached by the author of Chap. 15, are given at the beginning of this chapter and form a valuable summary

The effect of alkalies and oils upon concrete receives only passing mention.

The importance of this subject in the West especially would warrant a much more extended treatment giving the latest developments and investigations, indicating the dangers where alkalies are present and the necessity of proper materials (including water), proportioning and workmanship for protection.

The subjects of theory and design are treated in two separate chapters, and there is considerable repetition that could have been avoided; for instance, some of the sections under "theory" being repeated verbatim in the chapter on "design."

Chap. 10 deals with the proportioning of aggregates and contains a summary in heavy type of the laws relating especially to the grading of aggregates, and also the application of mechanical analysis to proportioning.

This, together with Appendix 1, on the method of combining mechanical analysis curves, should be of great assistance in obtaining the best kind of concrete.

The salient features of many of the chapters are brought into prominence by the use of summaries and heavy type, while, where several different formulæ are given under different assumptions, the authors state the formulæ recommended by themselves.

The great value of the book lies in the fact that it is practical in its treatment and applications, as well as giving the theoretical principles involved.

The authors are to be commended on the whole for the clearness of presentation and arrangement of the work, as well as on the matter contained.

The book is indispensible for engineers dealing with concrete work and design.

Railroad Engineering

By William G. Raymond, Dean of the College of Applied Science, State University of Iowa. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. Third edition, revised, 1917. 453 pages, $5\frac{3}{4}$ x $8\frac{1}{2}$ ins., 18 plates, 113 figures, cloth. Price, $4 net. (Reviewed by G. A. McCarthy, chief engineer, railway and bridge section, City Hall, Toronto.)

It seldom falls to the lot of a student to get within so few pages so many sound principles, so clearly set forth, on railroad inception, location, financing and valuation, as he finds in the introduction. The work consists of three parts.

Part I. In ten chapters, deals with rails and fastenings, ties, track, roadbed and structures, including signals which go to make up the permanent way.

Part II. In seven chapters, treats of the locomotive and its work, train resistance, grade and curve resistance, velocity grades, operating expense, and gives in a fair amount of detail, examples of problems met with by the railroad engineer when called upon to estimate the allowable expenditure to effect certain improvements in grade or alignment, or both. This chapter also contains twelve plates showing the different classes of locomotives, with particulars of size, weight, etc.

Part III. In six chapters, describes reconnaissance, preliminary, and location surveys, together with the estimate of cost of a railroad from such surveys. One chapter is devoted to construction surveys, methods of staking out work, overhaul, etc. One chapter of twenty-three pages is devoted to valuation. An appendix contains almost complete reprint from the Transactions, American Society of Civil Engineers, Vol. lii., of the paper by W. D. Taylor, M.Am.Soc.C.E., on "The Location of the Knoxville, La Follette and Jellico Railroad, of the Louisville and Nashville System." Most of the discussion of this paper is also included.

The author has treated of railroad engineering in a most practical manner, realizing that many of the problems are not subject to exact solution.

In dealing with matters which may be more or less controversial, the author, while expressing his preference, gives the student the opinions held by others. Many references are made to works of other well-known authors and to the Manual and Proceedings of the A.R.E.A.

The book is of convenient size, well arranged, clearly printed and practically free from errors.

One has only to go carefully through a volume of this nature to realize how great is the field covered by railroad engineering. The author has successfully covered this field in a general way, referring the reader to reliable sources of information, if greater detail is desired.

Every student of railroad engineering can make no mistake in adding this book to his library.

Gas Chemists' Handbook

Compiled by Technical Committee, sub-Committee on Chemical Tests, 1916; A. F. Kunberger, editor. Published by the American Gas Institute, New York City. 354 pages, 6 x 9 ins., illustrated, cloth. Price, $3.50. (Reviewed by J. Watson Bain, B.A.Sc., past-chairman, Society of Chemical Industry, (Canadian Section), Washington, D.C.)

As in so many other branches of chemical industry, the methods of control in the manufacture of gas have been wonderfully developed in recent years. The modern purchasing agent buys on specification and desires to know whether or not he is obtaining what he pays for, while the operating engineer judges the successful operation of the plant largely by the chemical analyses which are furnished to him. The older gas chemists contented themselves with determining the sulphur, ammonia and candle power of their product, and this volume of 354 pages, devoted to methods of analysis, shows very strikingly the progress which has been made. Until the appearance of this volume, there was no publication which dealt in a comprehensive manner with the various problems which fall to the lot of the gas chemist, and in many cases re-

course had to be made to the technical journals, some of which are not readily available. The publication of this compilation is, therefore, a great service not only to the chemist at the gas works, but to all chemists who have to deal with the problems of the related industries.

The subjects discussed comprise: Coal and coke, gas oil, purification material, gas analysis, heating value, tar, ammonium sulphate, lime, cyanogen, impurities in gas, tar products and light oils, miscellaneous, Portland cement, steel, alloy steels, etc. There are some excellent tables and a good index. The newest developments in the gas industry, such as the recovery of cyanogen and the recovery of benzol and toluol, are well covered and the descriptions are clearly written.

It would be difficult to conceive of a gas chemist to-day who would not desire to have this book on his shelf for reference, if not for daily use.

PUBLICATIONS RECEIVED

Berger Transit Bulletins Nos. 2 and 4.—Published by C. L. Berger and Sons, Boston, Mass.

New Brunswick Power Company.—Annual report for 1917. H. M. Hooper, secretary, St. John, N.B.

The Resources of Tennessee.—Quarterly, January issue, published by the State Geological Survey, Nashville, Tenn.

Back Pressure Valve.—Pamphlet describing and illustrating the Cochrane Multiport valve, issued by Canadian Allis-Chalmers, Limited, Toronto.

Street Flushing.—Catalogue of Tiffin 2-motor-system flushing and sprinkling machines. Sent on request by the Tiffin Wagon Co., Tiffin, Ohio.

American Railway Engineering Association.—Bulletin, nineteenth annual convention. Published by the association at 910 Michigan Avenue, Chicago, Ill.

Mineral Production of Canada.—Preliminary report for 1917. Prepared by John McLeish, B.A. Published by Mines Branch, Department of Mines, Ottawa.

Belts.—A monthly, containing information for users of pulley belts. Published and distributed free by the Federal Engineering Co., Limited, 172 John Street, Toronto.

Industrial Storage Battery Locomotives.—Catalogue No. 231. Interested persons can obtain free copies by writing to The Jeffrey Manufacturing Company, Power Building, Montreal, P.Q.

Tests of Small Telescopes at the Laboratory of the Dominion Land Surveys.—By E. Deville, LL.D., Surveyor-General of Dominion Lands. Bulletin 41, Topographical Surveys Branch, Department of Interior, Canada.

Block Survey Reiterating Transit Theodolite.—Six-inch micrometer, 1912 pattern. Description, adjustments and methods of use. By W. H. Herbert, B.Sc. Bulletin 34, Topographical Surveys Branch, Department of the Interior, Ottawa.

Combustion of Coal and Design of Furnaces.—Report of experimental investigations to determine the most efficient designs and operation of furnaces. Bulletin 135, published by the Bureau of Mines, Department of Interior, Washington, D.C.

Bennis Patent Coking Stoker.—Catalogue of a patent automatic stoker and self-cleaning compressed air furnace. Will be sent on request by Ed. Bennis and Co., Limited, publicity department, 28 Victoria Street, Westminster, London, S.W., England.

Experiments in Dust Prevention and Road Preservation, 1916.—Progress reports. Published by Logan Waller Page, director of the Office of Public Roads and Rural Engineering. Bulletin 586, United States Department of Agriculture, Washington, D.C.

Rare and Standard Books on Exact and Applied Science.—A catalogue of (including the scientific portion) the library of the late Rt. Hon. Sir James Stirling, F.R.S., etc. Issued by Henry Sotheran and Co., 140 Strand, W.C. 2, near Waterloo Bridge, London, Eng.

Sulphur—An Example of Industrial Independence.—Bulletin 102, Part 3, the Mineral Industries of the United States. By Joseph E. Pogue, of the Division of Mineral Technology, U.S. National Museum. Published by the Smithsonian Institute, U.S. National Museum, Washington, D.C.

Coal Products; An Object Lesson in Resource Administration.—Bulletin 102, Part I., the Mineral Industries of the United States. By Chester G. Gilbert, curator of Mineral Technology, United States National Museum. Published by the Smithsonian Institute, U.S. National Museum, Washington, D.C.

Percentage of Extraction of Bituminous Coal.—With special reference to Illinois conditions. By C. M. Young, Illinois Coal Mining Investigations Co-operative Agreement. Prepared under a co-operative agreement between the Engineering Experiment Station of the University of Illinois, the Illinois State Geological Survey and the United States Bureau of Mines. Issued by University of Illinois, Urbana, Ill.

The Canada & Newfoundland Development Company, North Sydney, N.S., are having plans prepared for six reinforced concrete scows Architects, Booker & McKechnie, Davidson Bldg., Halifax.

E. D. Creer, engineer of the Vancouver and District Joint Sewerage and Drainage Board, is asking for the establishment of a permanent maintenance gang. The sewerage system of the municipalities is worth over $2,000,000, and consists of over 20 miles of trunk sewers. For financial matters, the sewerage board makes the allotments, and the municipalities acting as collecting agencies. The allotments are divided so that 30 per cent. of the amount is borne by the whole sewerage district affected, and 70 per cent. by the immediate district benefited.

Railways and canals votes in the estimates tabled in the Commons at Ottawa include, in addition to the I.C.R. and Hudson Bay Railway votes: $700,000 for the Quebec bridge, $1,860,000 for the Welland ship canal, $500,000 for the Trent Canal and $250,000 for the National Transcontinental Railway. Public works votes include an additional $1,500,000 to cover the cost of construction of the new Parliament buildings at Ottawa, and $1,000,000 for the new departmental building at Ottawa. Harbor and river votes under this head include $350,000 for improvements at Port Arthur and Fort William, $150,000 for improvements at Vancouver, and a similar expenditure of $166,000 on Victoria Harbor, B.C. The total vote for public buildings is $2,620,000, as compared with $2,125,000 for the current fiscal year. On the other hand, harbor and river votes will decrease from $5,931,000 to $1,836,000. Estimates for public works in the Province of Ontario total $607,800, of which revotes amount to $180,300. Every item is in connection with the completion of buildings already under construction. For harbors and rivers in Ontario the total vote is $252,315, the main items being: $77,000 further for Port Stanley harbor improvements; $40,000 for repairs to Langevin pier; $14,000 for repairs to piers at Port Burwell, and $7,400 for repairs to breakwaters at Port Colborne.

THE EFFECT OF COVERING A SERVICE RESERVOIR*

By John Gaub

It is hardly necessary to say that no one at the present time expects to hear of such highly developed animals as fish or eels in a municipal water supply, especially after it has been filtered, yet in many communities where filtration has been adopted the water is served to the consumer from an open reservoir, thus permitting all manner of dust, droppings from birds, insects, microscopic growths and many other influences tending toward deterioration, to cause much trouble and anxiety. Although it may be possible to account for these various troubles and it may be shown that the water has been filtered properly, yet the layman will be of the opinion that the supply is not cared for in the proper manner and hence the usual complaint, whereas if the reservoir had been covered or protected in some way, everything would have been satisfactory.

The open surfaces of water, whether in service reservoirs, clear-water tanks or basins or channels, lend themselves primarily to the introduction and development of

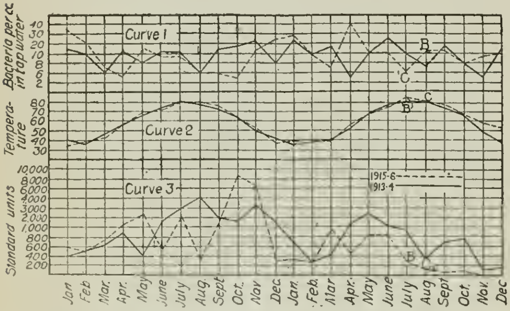

Fig. 1—Temperature and Bacteria Variations

algae and insects. The latter lay their eggs on the borders of the open bodies of water, in which when hatched the larvae spend one part of their existence as free-swimming animals before reaching a further stage in their development, thus permitting, sometimes, the consumer to obtain some of the larvae from the spigot in his home. Fortunately, many of these larvae and algae do not make the water-mains their permanent abode, and hence may be regarded as occasional passengers on an unknown journey. Especially is this so with algae, since they thrive best in the sunlight, and yet it should not be forgotten that such forms as Sponge and Crenothrix are met primarily in iron pipes.

As a result of the presence of algae in water basins, the water becomes subject to disagreeable tastes and odors resulting from the growth and decay of the organisms. Again, small organisms visible to the naked eye, such as Daphnia and Cyclops cause much worry on the part of the consumer when seen in the glass of water as drawn from the spigot. In most reservoirs the appearance of algae and the larger forms of life tend to act as scavengers, living on the organic matter, bacteria and other ingredients which the water might have picked up in its flow. Especially is this so in the case of surface waters. However, when these forms of life die the bacteria increase in numbers, and though they be only water forms and have no significance still they do not improve the water in any way; this is easily seen when curves 1 and 3 in Fig. 1 are compared, especially for the spring, summer and fall months. From these curves it will be seen that where there was an abrupt change in the algae growths (curve 3) the bacterial content was not affected, in some instances increasing; whereas when the algae were permitted to grow the bacteria were kept down.

Now, with water of this kind, especially after it has been filtered, two things are possible in order to protect it from deterioration, *viz.*, (a) the use of an algicide, (b) the building of a cover for the basin. Copper sulphate is recognized as an algicide everywhere, being used in many cities to prevent and stop the effects of vegetable and animal growths in the water supply. Undoubtedly if used in ample sufficiency and under proper conditions it will destroy everything that affects the aesthetic sense of man in a water supply. However, it has been found that the toxicity of copper salts is low in water containing calcium and magnesium carbonate, in which case the copper is precipitated as basic cupric carbonate, which in turn is slowly dissolved by the carbon dioxide in the water, hence necessitating a larger dose than would be the case with a softer water. Again, when copper sulphate is used at a time when the growths start and before the organisms have developed so as to form a mass, the water becomes full of dead and decaying bodies of the organisms, which due to stagnation cause an effect opposite to that which was intended; after which, in a short time, under favorable conditions, the growths begin again and the same operation must be repeated if some satisfaction is desired. In many cases the effect has been so marked that the reservoir was placed out of service until it was cleaned. In many cities treatment with copper sulphate is begun in the early spring thereby thinking that a good foot-hold will be established by which to check the growths, only to find that in a short time the growth is appearing.

Hence, when everything is considered, labor, material and incidentals, and the number of repetitions in applying the algicide together with the after results, it will be found that the total sum spent equals the interest on the money invested in a good cover for the body of water, especially if the water has been filtered. This, in brief, is what was done in Washington to one of the service reservoirs, thereby eliminating a very troublesome growth of algae, most of which were diatomaceae.

Briefly, the cover was designed as a flat slab concrete floor to carry a live load of 75 pounds per square foot. The reservoir is in two compartments, and one of these was covered while the other was in service, thus causing no delay in the use of the water in that section of the city. The slab is 6 inches thick and is supported on 133 columns 16 inches square. The slab is made of a mix consisting of 1 part (Portland) cement, 2 parts sand and 4 parts gravel, and covers 44,600 square feet. The cost was about 37 cents per square foot.

In studying the effect of an improvement such as this, several facts make themselves known which in a way influence the quality of the water, thereby proving that it was a success. These are: (1) the location of the reservoir, which controls to a degree the physical influences; (2) the effect of such a change on the bacteriological and chemical content of the water; and (3) the all important one, the discontinuance of former microscopic growths.

The temperature of the water, as will be seen from curve 2, Fig. 1, was constant, not having changed in the last four years, and ranging from a minimum of 35° F.

*Journal of the American Water Works Association.

to a maximum of 80° F., thus giving the various organisms their respective optimum temperatures for growth. However, when the cover was applied, as shown between the points B and C on the curve (Fig. 1) the temperature did not fall so readily as when the reservoir was open, thus permitting the bacteria to thrive but to no alarming extent, as is seen from curve 1. Again, the effect of the cover is seen in Table 1, in that the total nitrogen was not as high as it was formerly, due to the lack of organic matter which entered by way of the wind. This is also seen in the amount of amorphous matter which was usually present in the open reservoirs; in this case it followed curve 3, and hence is omitted.

The effect on the chemical constituents will be seen from Table 1, in which it will be noted that the total nitrogen, nitrites and nitrates decreased due to the lack of

TABLE 1

Effect of the cover on the chemical constituents, in parts per million

MONTH	TOTAL NITROGEN				NITRITES				NITRATES				ALKALINITY			
	1913	1914	1915	1916	1913	1914	1915	1916	1913	1914	1915	1916	1913	1914	1915	1916
August	0.109	0 040	0 109	0 105	0 004	0 007	0 004	0.003	0 20	0 10	0 20	0 22	76 5	74 0	55 8	64 0
September	0 051	0 19	0 024	0 024	0.002	0.005	0 004	0	0.15	0.25	0 38	0 10	87.2	62 0	67 8	76 0
October	0 054	0 021	0 021	0 020	0.001	0 005	0 004	0 002	0 20	0 24	0 37	0 15	87 2	60 0	71 5	79 6
November	0 031	0 018	0 037	0 017	0.005	0 003	0 003	0 004	0 80	0	0 36	0 10	65 4	71 5	81 2	76 1
December	0 032	0 060	0 032	0 019	0 003	0 002	0 002	0	1 10	0 30	0 30	0	55 4	71 3	64 0	79 6

added organic matter, which in former times was carried in by the wind and birds; again this decrease was due to the decreased number of dying algae, etc. Again, the alkalinity appears to vary in times previous to covering, due no doubt to the varying amount of carbonates and bicarbonates, in which case the carbon dioxide was used by the organic growths; on the other hand, after the cover was added, the alkalinity appears to remain constant. If water plants enter a body of water which is open to the air, as this one was, the mineralized nitrogen and carbon dioxide are used as food, thus causing the plants to excrete substances which to higher life are poisonous. The oxygen consumed, in this case was reduced between 0.2 and 0.3 cubic centimeters per liter, pointing to the fact that something that was at work had now stopped. Hence it is evident that if factors like those above mentioned are controlled the water will not and should not deteriorate.

In curve 3 it will be seen that the microscopic growths have been somewhat excessive, and in those places where a sudden drop is seen either cleaning or copper sulphating or both had been practised, showing an immediate effect but not the permanent one desired. However, when we come to the points B and C an immediate drop is seen, which in comparison with that for former years at the same times appears to be permanent, so that in the future very little microscopic growth may be expected in this reservoir.

Conclusion

Hence for the following reasons every reservoir used for service should be covered.

(1) From an aesthetic sense, in that all matters which have been removed by filtration are kept out.

(2) By keeping out all manner of debris the chemical composition is not changed much, in fact not so much as it would be without the cover.

(3) The temperature will not vary as much, during all seasons of the year, as without the cover.

(4) The expense of treating and cleaning the reservoir, thereby sometimes causing much inconvenience to the consumer, is avoided.

(5) A flat taste may result from the use of the cover, this, however, can be eliminated by constructing the reservoir so that a constant circulation is maintained.

(6) By constructing the cover flat an eye-sore is eliminated in the vicinity, since the cover can be used as a base for a bed of flowers or a garden, thus improving the appearance of things around the reservoir.

TORONTO SECTION, AM. INST. OF E. E.

Nearly fifty per cent. of the members of the Toronto Section of the American Institute of Electrical Engineers attended the meeting held March 15th, when J. J. Frank, of the General Electric Co. of Pittsfield, read a paper on "Modern Transformers." Twenty per cent. of those present took part in the discussion.

The next meeting of the Toronto Section is to be held at the Hydro-Electric Laboratories on Strachan Avenue, Friday, April 5th, when W. P. Dobson is to read a paper on "High Voltage Testing."

CANADIAN RAIL ORDERS IN UNITED STATES

New York dispatches state that the Canadian government railways are in the United States market for 5,000 box cars after placing an order for passenger equipment with the Pullman Company, and ten narrow-gauge engines with the Canadian Locomotive Company.

The Grand Trunk has recently ordered 25 switching engines from the same builders. The Pennsylvania Tank Car Company has taken orders for tank cars from steel companies and from oil refiners. Oil companies continue actively in the market for railroad equipment. Ten companies ask for 600 tank cars, which will require about 9,000 tons of steel.

In the statistical review of the Mineral Industry of Ontario for 1916, the Deputy Minister of Mines notes that the tendency in the mineral industry of Ontario, particularly in the metals, is towards the production of the finished article, as contrasted with the mere mining and selling of the raw ore or material. Molybdenite and lead have not been mined extensively in Ontario so far. The making of war munitions, however, has for the time being, stimulated the demand for both metals. Concentration plants for molybdenite have been followed by the installation of plants at Orillia and Belleville for the manufacture of ferro-molybdenum. Formerly, the English supply of this alloy came entirely from Germany. Another ferro compound, ferro-silicon, is being made on an extensive scale by Electro Metals, Limited, at Welland. A smelter for the production of pig lead has been installed at Galetta on the Ottawa River, to treat the ore raised from the lead mine at that place. About 400 tons of lead were made in 1916. When the plans of the British-America Nickel Corporation are fully carried into effect, there will be two nickel refineries in operation of capacity equal to the demand for the metal from the entire British Empire. A company has also been formed for the manufacture of nickel-copper steel direct from the Sudbury ore, recent investigations and experiments having shown that the prejudice against the presence of a moderate proportion of copper in steel is not justified by the facts. The next logical step in the development of the nickel industry will be the establishment of plants for the making of nickel steel, either from imported or domestic iron ore if the latter can be had in sufficient quantity. Not much has yet been actually accomplished in the treatment of copper ores. The increased demand for fluorspar has come largely from steelmakers. It is used chiefly as a flux, but also in the manufacture of hydro-fluoric acid, and in certain metallurgical operations. A newer use is in the recovery of potash from feldspar and from Portland cement clinker. The last previously reported production of fluorspar was in 1911, when $200 worth was marketed. In 1916 the shipments amounted to 1,283 tons, valued at $10,146, the price averaging nearly $8 per ton.

POSSIBILITIES OF THE RELIEF OF FUEL CONSUMPTION IN CANADIAN INDUSTRY BY THE INCREASED USE OF HYDRO-ELECTRIC ENERGY*

By J. M. Robertson, M.Can.Soc.C.E.

THE growing necessity for some comprehensive plan looking towards the more complete and efficient utilization of our resources has been apparent for many years to those whose duties make them familiar with the tremendous wastage of materials which results from the lack of co-ordination in the use of the various raw materials with which our country is so richly endowed. The public, generally speaking, has little real idea as to what constitutes the real essential of conservation of natural resources. Simple reduction in demand; the restriction of the use of such materials, thereby restricting the output of essential industries is obviously not true conservation. The goal to be aimed at is development, present and future, and in order to secure this end we must make use of such materials as are necessary for the maintenance of our trade and commerce and the growth and development of our national life. Economic utilization of such resources, considering both present and future, would limit the use of irreplacable materials even though they might be more cheaply and readily obtained under given conditions, and promote the use of other materials whose use conserves to a greater extent the assets of the community. The elements of cheapness and availability of raw materials are large factors in determining the success or failure of any industrial enterprise and as such must be given due weight. We have been, however, and we are still, too much inclined to accept these factors as excuses for taking the material nearest at hand which is suitable for our purpose and letting the future take care of itself. A little thought and investigation devoted to the development of possible substitutes will frequently disclose methods by which an industry may utilize materials or processes the use of which does not deplete the resources of the country. The ideal conservation would provide for the maintenance of the industries of the world by the use of basic materials supplied from natural growth so that the stock of raw material which constitutes the capital of the world would not be reduced but would be handed down unimpaired from generation to generation. Such an ideal conservation is obviously beyond reach in our present stage of development but, although we are still using up our capital at an alarming rate, the increasing realization of the need of care and the increasing efficiency of utilization which science is placing in our hands makes the future look more hopeful than might be considered warranted by a consideration of the special and temporary restrictive measures which have been applied to industry as a whole during the past few months. From these experiences it is apparent that the most essential elements in our industrial life at present are transportation and fuel, and to a large extent transportation means fuel since the equipment required for transportation can neither be produced nor operated in the absence of an adequate supply of fuel. It therefore follows that any modification of our past practice which will maintain our industries and at the same time reduce the consumption of fuels will be an application of true conservation principles in more than one way as, first, it will reduce the consumption of a material which once used cannot be replaced, and secondly, it will reduce the demand for transportation for such material as will thereby leave for the use of some other industry a larger supply of raw material for which for its purposes there is no substitute.

The use of raw coal as a basis for the generation of power through the medium of steam is fundamentally uneconomic, as too large an amount of valuable by-product is sacrificed for very little return and the efficiency of the conversion is much too low. When it is considered that under average conditions the amount of coal required to generate a horse-power hour is of the order of five or six pounds, representing an efficiency from coal to power of only 3 or 4 per cent., which, generally speaking, must be again divided by two before the energy is applied to the work, it can be readily realized that our present methods of operation leave much room for improvement. In defence of the steam plant it may be claimed that such figures represent only the practice of the smaller plants and that in the large manufacturing centres power is supplied from steam plants which operate much more efficiently. It is a very good plant which can average a kilowatt hour on 1½ lbs. of coal, including all auxiliaries, so that even under the best conditions we get an efficiency of only about 15 per cent. It is, of course, necessary to remember that such low efficiencies are not due to imperfections in the equipment but rather to the limitations imposed by thermal laws and until a method of conversion radically different from the present has been discovered, such losses cannot be eliminated.

These figures, unsatisfactory as they are, tell only half of the story. In using raw coal we are throwing away in a wasteful manner material which contains many valuable by-products which add but slightly to its value as a fuel but which when extracted have a value greater than the value of the coal itself. Many of these materials are essential elements in our industrial life for which at present there are no substitutes.

Notwithstanding this very unsatisfactory showing, the necessities of the case require that coal should be used for fuel in the absence of better means of providing readily available energy. It would seem, however, more or less elementary that the use of coal for such purposes should be restricted to cases where no substitute is available in order that when science places in our hands improved means of converting fuel into power, we shall not be in the unfortunate position of having squandered our patrimony and left ourselves without the means to take advantage of the improved processes when available.

Climatic conditions in this country, owing to the northern location, impose upon us a heavy burden every winter. Heat must be maintained in our houses and shops. At this stage of progress the only generally available means of heating is by fuel—coal, oil or gas—of which the former is by far the most important. We cannot avoid the use of coal for heating our factories, but we can see to it that as soon as practicable raw coal is not used for this purpose, and that what fuel is used is for heating purposes only wherever adequate substitutes for coal-generated power are available. Too many of our industrial establishments are operated entirely by coal simply because the controlling head likes the idea of "independence" and declines to consider the purchase of public service supply because he would then be "dependent on the power company." In places where hydro-electric service is available the power required by such establishments should be purchased and generally is purchasable at rates and under conditions more favorable than the costs of operation by coal and with much less investment

*Paper read before the First General Professional Meeting of the Canadian Society of Civil Engineers, Toronto, March 27, 1918.

for plant. In the cases of factories located where such service only is obtainable, sufficient engine plant should be installed to make possible the abstraction of the maximum amount of energy from the steam before it is used for heating, the idea being to operate steam plant only to the extent of the heat requirements utilizing the steam equipment as the reducing valve and increasing or decreasing the purchased power to such extent as may be required to offset the variation in the by-product power recovered from steam required for heating or process work.

As the average manufacturing establishment in most parts of Canada require more steam for heat than for power during the winter months and almost no steam during the summer months, and as the demand for electric energy for lighting purposes is much greater during the winter, such an arrangement works to the advantage of both company and consumer, as the combination makes possible the almost ideal utilization of the energy in the fuel during the winter and the capacity on the power system thus released becomes available to take care of the increased load which must be carried electrically. The diversity thus introduced into the power demand makes possible the fixing of a power rate which is attractive to the consumer and at the same time remunerative to the power company.

In some plants, considerable ingenuity is displayed in so combining equipment for utilizing steam, electricity and compressed air or refrigeration with outside service so that no fuel whatever is burned, except for supplying heat, and every possible unit of energy is abstracted from the steam before it is utilized as heat. Variation in the demand for air and electricity is compensated for by use of machinery driven by two sources of power involving very interesting cross-conversion of energy.

The experience of those who have plants operating under these conditions is quite satisfactory as they have secured the convenience of freedom from unnecessary heat and dirt during the summer, the advantage of a standby plant as protection against shut-down—extremely low cost of power during the winter and a satisfactory power service available at all times when required.

The fact that such economies are usually realized in plants of considerable size is due principally to the fact that the large plants are directed by executives of broad views who realize that elimination of waste is desirable even though in a given case it may not result in a net saving of money.

Instances have arisen this year in which factories which operate by steam power in winter and purchase hydro-electric power during the summer months have anticipated the date for the commencement of this purchased service with the consent of the power company, and are reducing their coal consumption as weather permits to the minimum absolutely necessary for heat and are paying to the power company for service to make up the deficiency in power recovery the net amount they would have paid for additional coal. The power company, having power available, is satisfied to accept this amount for temporary service from month to month without further obligation on the part of either party. Such co-operation shows evidence of broadmindedness on the part of all concerned and leads us to hope that further progress in co-operation would develop many other instances in which very real savings could be made to the advantage of the country as a whole.

An indication of the extent to which an enlightened policy under favorable conditions can carry the substitution of hydro-electric service for steam in an industrial community is given by a comparison of the figures representing the consumption of electrical energy in the more important industrial centres in America. For the year 1916, the figures in kilowatt hours per head of population were as follow: New York, 225; Philadelphia, 250; Boston, 350; Cleveland, 400; Minneapolis, 450; Pittsburg, 500; Buffalo, 585; Toronto, 700; Montreal, 783. The figures for 1917 are not yet available but it is probable that the figures for both Toronto and Montreal would show an increase of about 10 per cent. Montreal would thus be about 800 while the whole province of Quebec was about 700.

The total power utilized in the Montreal district is about 200,000 h.p., of which about 165,000 is supplied from hydro-electric sources and the balance by steam. If the city pumping plant and the plant of the Tramways Co. are excluded the total steam capacity now in regular operation in this territory would be about 10,000 to 12,000 h.p. or about 5 or 6 per cent. of the total power utilized. Even this small part of the demand would be reduced materially were it not for the fact that most of these plants are of a kind which produce large quantities of combustible waste which must be disposed of by burning or are plants in which there is relatively large demand for high temperature steam for process work and a relatively small demand for power.

When it is considered that the amount of coal required to replace the electrical energy supplied by these hydro-electric plants would be of the order of 1,750,000 tons per year it is clear that while there still remains much to do, a very considerable amount has been done.

It should be borne in mind that this is no isolated instance. What has been done here is being done to a greater or less extent in many other centres, as is clear from the large and increasing load carried by the hydro-electric system in Ontario. Toronto's use of current is almost equal to that of Montreal and both of them are quite remarkable for very complete utilization of purchased power. Co-operation between the consumer and the company with fair rates and conditions for service rendered and a reasonable willingness on the part of the consumer to adapt himself and his plant to new conditions, even when such adaptation may perhaps entail the sacrifice of a little of his apparent independence, will assist our power companies in improving the already high character of the services they are now rendering by reducing to a minimum the utilization of irreplacable materials and extending and broadening the use of power supplied from inexhaustible natural sources.

The development and utilization of our water power reserves is a measure of our economic advance in the scale of civilization, and the formulating of a broad and liberal policy which will ensure the keeping of such development in advance of the requirements of our industries is something which should engage the attention of our government and our industrial leaders.

It is surely not too much to hope that in a country so richly endowed with natural power sites, distributed almost ideally from an economic standpoint the time will come when practically all of the power required for our industrial life will be supplied from such sources, and we will be free from the reproach that because it is easy and obvious we cheerfully squander our patrimony while we neglect to develop the natural heritage with which a wise Providence has blessed us.

A Seattle syndicate, believed to represent the Pacific Coast Steel Corporation, has bought a manganese mine near Kaslo, B.C., for $160,000. Concentrators are being installed.

READJUSTMENT OF INDUSTRY

How to maintain efficient production with competitive co-operation was the second problem discussed by Colonel David Carnegie, M.I.C.E., F.R.S., Edin., at the recent annual meeting of the Canadian Mining Institute, Montreal. Colonel Carnegie, who is a member and ordnance advisor of the Imperial Munitions Board, Ottawa, had first considered as to how to secure remunerative trade without unrestricted competition.

The problem of the maintenance of efficient production with competitive co-operation affected two classes of labor, said Colonel Carnegie, the employer and the employed. "The intelligent employee to-day not infrequently becomes the prosperous employer to-morrow." He continued. "Such boards of control as we are now considering (outlined in these columns last week), would encourage this tendency.

"While in considering the first problem the curse of unrestricted competition is revealed and condemned, I wish to emphasize just as strongly the true value of maintaining efficient production with competitive co-operation, and, further, that regulated competition in production is a healthy inspiring incentive, producing the best results without having any of the evils attending that unfair competition which secures trade. Competitive co-operation is indeed the life of industry when applied to efficient production. It inspires the best service in the individual worker while producing contentment.

"This condition is not overdrawn, and I am sure that much unrest exists regarding the future relations of capital and labor. Since the war began commissions have been appointed to investigate the far-reaching problems of industry, and recommendations have been made concerning the relationship between capital and labor, the development of industrial research, the employment of the best kind of machinery, the best methods of manufacture, buying and selling products, transportation, facilities, domestic and foreign commercial relationship, together with a host of other subjects of vital importance to the industrial prosperity of the Empire.

"For years past there have been constant conflicts between capital and labor on one or other of the issues I have named. Prior to the war in the United Kingdom strikes were so common and so virulent that they threatened to menace the public safety.

"In March, 1917, the Whitley report of the Joint Standing Industrial Councils was presented to the British parliament. In that report recommendations were made for improving the relations between masters and men and for establishing joint standing industrial councils composed of employers and employees, to obtain harmony and better means of production. Ever since the war began committees and commissions have been at work to solve the problems. It is hoped that the work of these bodies will be of service to the reconstruction committee of the cabinet of the Dominion government.

"These investigations instituted by government indicate the need of changed conditions It is unnecessary for me to go into details regarding the causes of mutual distrust and suspicion between employers and employed. I would rather, if time permitted, exalt the spirit which is changing daily, the relations of employer and employed, and making possible a speedier union of their efforts in the general harmony of their interests. I believe the way to secure that harmony is by recognizing organized labor and letting them share in a larger manner the responsibility of the output, quality and profits of industry. The following proposals for the formation of production boards are suggested with the hope that they may meet the need.

"1. That production boards be formed for each industry in the same number as the district trade boards, and be incorporated by law to deal with specific duties defined in the articles of association.

"2. The boards to be independent in their control and operation of all matters under their jurisdiction, but to work in direct and harmonious association with the industry trade boards.

"3. Each board to consist of elected representatives of the employers and employees of each industry from the same number of manufacturers and within the same geographical boundaries, as determined by the scope of the industry trade board.

"4. Equal numbers of employers or their representatives, and employees or their representatives, to be elected by the district employers' association, and employees of the industry, whether the masters or men belong or do not belong to employers' associations or trade unions. The idea being to have full representation of each side belonging to the industry of the district in question. The method of election is a detail of organization.

"5. The chairman and vice-chairman to be nominated by the board as a whole. The chairman to be nominated from the elected representatives of the employers and the vice-chairman to be nominated from the elected representatives of the employees. Approval and election of both to be sanctioned by government and for the period of their election their services to be secured by the government.

"1. The acceleration of output by the introduction of the most important processes and plant used in any part of the world in the same industry. The consideration of this phase of the board's work to be placed in the hands of a committee who would investigate all modern improvements, review current scientific journals and reports of investigations relating to the industry. The committee to report periodically to the board, making recommendations for improved production. The board would consider and submit such recommendations to manufacturers associated with the board, and leave it to them to make such improvements as they consider desirable. The board would not accept responsibility for the results.

"2. To consider the provision of suitable industrial, technical and commercial training for boys, girls, men and women, with the object of improving the output and the quality of the product. A small committee of the board to investigate this subject, always with a view to training for the specific industry represented by the trade board. This section of the board's work would cover a very wide but necessary field of operation. It would embody:—

"(a) The vocational training of the child in preparation of his or her entry into the industry; (b) the education of the actual producers (principally manual); (c) the education of the directors of production (both manual and technical); (d) the education of the distributors of production (principally financial and commercial).

"3. To consider the classification, certification and valuation of labor. Another committee of the board could be formed for this definite object, having in view:—

"(a) The classifying of apprenticeship or in drafting boy and girl labor from vocational schools into those sections of industry best suited for their health, aptitude and age.

"(b) The certification of apprenticeship after probationary period in works, or office, to satisfy all concerned that the right employment has been selected for the child.

"(c) The classification of boys and girls after completion of apprenticeship for further training as draughtsmen, foremen, managers, salesmen, accountants, etc., according to the quality of the talent they had developed during their apprenticeship.

"(d) The classification of craftsmen of the same vocation, such as moulders, pattern makers, machinists, gauge makers, etc., into different skilled classes—say, 1st, 2nd and 3rd class moulders. The classification would distinguish between the good and very skilled moulders. Such classification is common in the civil, military, naval and professional services, where each receives a diploma, certificate or badge, indicating his ability, class or rank in the services. Labor unions classified their trades but not the ability of one individual as compared with another, although there are widely marked differences between the skill of moulders for instance. This neglect of classification has been one of the greatest causes of friction between the employer and the employed. The complaint has been that the skilled worker has not done more work than the indifferent worker. To initiate this work by one of the committees of the board with proper means for the certification of all labor by examination (manual or oral), by craftsmen in the art, would be a great service. The board to issue certificates indicating to what trade and class they belong, just as 1st, 2nd and 3rd class certificates are issued to the marine and land stationary engineers, sailors, miners and to others in different vocations. Arrangements to be made for the periodic renewal and O.K.'s of certificates. Such certificates to carry the board's district rate of pay. Should the holder of the certificate wish to leave the district over which the board presides, the certificate to be presented to the board to be O.K'd, so that on presentation to a new employer in a different district his value would be known at once.

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Principal Contents of this Issue

RAILROAD RATES

THE increase of 15 per cent. in railway rates authorized by the Railway Comission has been approved by the Governor-in-Council, and became operative from March 15th until one year after the end of the war. There was no other decision, consistent with the facts, open to the government. While the cost of all factors of railroad operation has rapidly increased, the companies were not allowed to charge any more for the commodity, transportation, they sell. The result has been clearly reflected in earnings in which the government is now vitally interested.

The Canadian Pacific Railway with the other roads, will charge the increased rates but it has to contribute to the public revenue one-half of its net earnings from railway operation in excess of 7 per cent. on its common stock. This is the present rate of dividend paid from this source. Upon the revenue derived other than from railway operations, such as lands, steamships, hotels, and telegraphs, the company must pay income tax, which under the legislation of last session of Parliament amounts to 25 per cent. on incomes over $100,000. The wording of the provisions of the order-in-council apparently means that the payment to be made by the company to the public revenue shall be up to $7,000,000 annually, and a larger sum if the increase in net earnings from the 15 per cent. higher transportation rates exceeds net earnings in 1917 by more than $7,000,000. Thus, whatever additional revenue the Canadian Pacific Railway derives from the new tariff of rates will accrue to the government. The special taxes imposed are obviously aimed at this company, which is tantamount to an admission that in the case of the other railways, such as the Canadian Northern, the Grand Trunk and the Grand Trunk Pacific, the higher rates will not produce net earnings in excess of charges on capital. The Canadian Pacific is actually to be penalized for its prosperity, built chiefly on efficiency and good management. A Montreal dispatch quotes a high official of the company to the effect that the corporation does not regard the new law as confiscatory. The dispatch concluded: "The Canadian Pacific Railway is not complaining." That has always been the spirit of this well-managed Canadian enterprise which has helped in innumerable ways and continues to do so to perfect the war organization of Canada and the British Empire.

Our railroad problem is not yet solved but the exigencies of war have brought a temporary measure. The outstanding features are the willing diversion of a large part of the company's profits to the conduct of the war, the maintenance of the company's and Canadian credit generally by the allowance of 10 per cent. dividends to the shareholders, and the recognition of the inadvisability of the nationalization of the Canadian Pacific Railway.

TRADE AND INDUSTRY AFTER THE WAR

DISCUSSING in a clear and able paper last summer, the industrial situation and outlook, G. Frank Beer, of Toronto, pointed out that Canadian factories were for the most part like young robins with open mouths into which the Munitions Board dropped orders averaging $1,000,000 a day. How can we prepare for the time when these activities cease? That question remains unanswered. There may be unforeseen factors, favorable and adverse, which will affect the situation after the war, but no good reason exists for postponing intelligent preparation for these post-bellum problems. Mr. Beer recalled that an organization of each separate American industry for export trade is the object of a trade commission now sitting permanently at Washington. "The form which such an organization should take," he said, "to meet Canadian requirements can not be decided upon without a most careful and thorough enquiry, and such an enquiry should be engaged in at once by the federal labor department, the department of trade and commerce, or other government authority in co-operation with a carefully selected committee of industrial leaders and labor representatives." He also referred to the important functions which a competent board of industry might exercise in connection with national production, adding: "Service of equal value should be provided for in connection with the problems of marketing. An effort has been made to show that only by the consideration of production and marketing, as constituting one problem, can the problems of each be adequately dealt with. The experience of the past two years has demonstrated the desirability, and indeed the necessity, of enlisting the services of successful and practical business men to control and administer work of this nature. A nucleus for the board of industry proposed lies within the personnel of the present Imperial Munitions Board. To a board of this character might with safety be assigned the task of co-ordinating and strengthening the work of all government departments now having to do with export trade."

Col. Carnegie, a member and ordnance advisor of the Imperial Munitions Board, apparently having read Mr. Beer's exposition of the subject, has now advanced a detailed scheme to solve two problems, namely, how to secure remunerative trade without unrestricted competition and how to maintain efficient production with competitive co-operation. An abstract of his address appears on another page of this issue. His plan to combine the activities of

our manufacturers would undoubtedly be opposed both by our industrial captains and by the public. It would probably discourage initiative and investment of capital, and what is most dangerous, it would tend to create large monopolies. Col. Carnegie's ideas with regard to organization for export trade are far more practical and should receive the consideration of the government and manufacturers. His plan, as a whole, however, looks impracticable, even in these days when we are bound to recognize the necessity of drastic changes in our conduct of affairs. That fact, however, does not remove the necessity for consideration of these important problems, and Col. Carnegie is to be commended for his investigation of them.

PERSONALS

M. V. SAUER, chief engineer of design of the Greater Winnipeg Water District, has resigned to accept a position with the Ontario Hydro-Electric Power Commission. He will leave the district's employ April 30th.

FREDERICK FIELD, engineer superintendent of the Montreal, P.Q., filtration plant, is asking for indefinite leave of absence to take a position under the chief engineer of the Housing Department of the U.S. Shipping Board in Washington.

J. H. LAMB, ex-president of the Alberta Association of Local Improvement Districts and Rural Municipalities, and a member of the Municipal Hail Board, has been appointed municipal commissioner for Alberta, a new office on the staff of the Department of Municipal Affairs.

Lieut.-Col. WILLIAM G. MACKENDRICK, D.S.O., Toronto, who has recently returned from the Front, received his decoration for his work as director of roads with the Fifth British Army. In civilian life, he was president of the Warren Bituminous Paving Company of Ontario. Debarred by his age from the combatant branches of the service, he went overseas and offered his services to the British War Office. He was there able to convince the authorities that his knowledge of road-building would be of practical use to the Allies and was given a captaincy in the Royal Engineers. There his ability in rapidly constructing roads fit for the heaviest traffic, quickly brought him into prominence and he was promoted first to the rank of major and then as lieutenant-colonel, made director of roads for the Fifth British Army. In appreciation of the services which he rendered at the Front and which involved the saving of hundreds of thousands of dollars in road construction, the Imperial Government conferred the Distinguished Service Order upon him. His son, Lieut. Gordon King MacKendrick, has found a soldier's grave in France.

OBITUARIES

HUGH O'DONNELL, P.L.S., C.E., who has been engaged in engineering work in Quebec city for nearly fifty years, died suddenly at his home there on March 13th. One son, John O'Donnell, C.E., is in the employ of the Imperial Munitions Board, Montreal.

Members of the county roads committee of Peel, Dufferin, Wellington and Grey, which met in Toronto on March 19th, were given official assurance that the Toronto-Sydenham road would be taken over as part of the county provincial roads system.

SIR COLLINGWOOD SCHREIBER

One of the greatest figures in Canadian engineering circles passed away on Saturday morning, March 23rd, shortly before nine o'clock, in the person of Sir Collingwood Schreiber. The death took place at his home, "Elmsleigh," Argyle Avenue, Ottawa, where he had been ailing for some months. The deceased was the son of Rev. Thos. and Mrs. Sarah Schreiber, of Bradwell Lodge, Essex, England, where he was born on December 14th, 1831, and was educated in England. He was twice married. His first wife, Caroline, daughter of the late Lieut.-Col. A. H. MacLean, of Her Majesty's 41st Regiment, died in 1892, and his second wife was Julia Maude, daughter of Hon. Justice Gwynne, of the Supreme Court, Canada, whom he married in 1898

For sixty years the late Sir Collingwood has been actively associated in the construction and development of both public and privately owned railways in Canada. He had a tremendous share in planning transportation systems, both east and west, and in the latter part of his career, as deputy minister of railways and canals, he helped to wisely administer lines directly under the government and subsequently superintended the construction of the Grand Trunk Pacific.

He came to Canada in the year 1852 and secured a position on the engineering staff of the Toronto and Hamilton Railway. He stayed with this road until 1856. By that time he had become known as an efficient and capable engineer. He was taken into partnership in the engineering firm of Fleming, Ridout and Schreiber, of Toronto, thus becoming associated with Sir Sandford Fleming. From 1860 to 1863 he superintended the construction of the Northern Railway, now a part of the northern division of the Grand Trunk. He was then invited by the Nova Scotia government to assist in the development of railways in that province. He remained there until 1867, and was subsequently connected with the Temiscouata section of the Intercolonial Railway.

He built and became superintending engineer of the eastern extension line, now part of the Intercolonial, and having played such a great part in the development of government railways, he was appointed chief engineer and general manager of all government railways in operation in 1873. Seven years later he succeeded his old partner, Sir Sandford Fleming, as chief engineer of the great transcontinental line, the Canadian Pacific Railway. He retained his position on the government railways, and on the Canadian Pacific Railway until 1892, when he was appointed chief engineer of the department of railways and canals. Later he became deputy minister of this department and for thirteen years administered the railway and canal policy of the country as permanent head of the service.

In 1905 he became general consulting engineer to the Dominion government and chief engineer of the western division of the national transcontinental railway. Since that time his chief work has been the inspection of the construction of the Grand Trunk Pacific. Year by year since the road was begun he has made his annual trips of inspection. Even when he had attained the age of 79 years he covered 500 miles on horseback in connection with the survey of the line. He was a big man physically, and possessed a magnificent constitution. His faculties remained bright until the end.

A concrete interior, estimated at $100,000, is under construction in the process and offices building of the Simcoe Canning Factory.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Canada's Water Powers and Their Relation to the Fuel Situation

Canada Abounds in Valuable Water Powers—Location of Waterfalls Admirably Suited to Commercial Centres and Related Raw Materials—Paper Read Before the First General Professional Meeting of the Canadian Society of Civil Engineers, Toronto, March 26-27, 1918

By J. B. CHALLIES, M.Can.Soc.C.E.

Superintendent, Dominion Water Power Branch, Department of the Interior, Ottawa

THE subject assigned to me in connection with this fuel-power symposium meeting of the Canadian Society of Civil Engineers is the relation of water power to the fuel situation in Canada. At first "blush" it might appear that water power has only an indirect and limited connection with the recent critical fuel shortage which through suspended effort has caused temporary industrial stagnation and local domestic hardships of enormous extent and involving great financial loss. Even a casual general survey of our fuel-power requirements, however, will indicate that not only has water power a very direct and important bearing on the present situation, but that water power must, in the future, take a very much greater share in our fuel-power burdens.

Heat, Light and Power Needs—One Problem

It is axiomatic that our heat, light and power needs must be considered as one great national problem, and also that Canada's domestic and industrial development depends primarily on the co-ordinated use of all the fuel-power resources of the Dominion.

Development along independent and divergent lines has, in the past, prevented adequate correlation of the great Canadian industries of fuel production and hydro power supply. There is now, however, as a result of the fuel shortage, developed a consensus of opinion among men familiar with fuel and hydro power matters in Canada, that there is between these allied industries, enormous scope for national co-operation which would be conducive to their mutual advantage, as well as to the common weal.

I propose to show: First, that water power must take a very prominent part, if the best use of the varied fuel-power resources of Canada is to be achieved; and second, that there must be evolved a national master fuel-power policy which will realize the best possible co-ordinated and concomitant development and use of all the fuel-power resources of the Dominion.

Interdependence of Water Power, Coal, Wood, Peat, Oil and Gas

Within the last two days we have had recognized experts describe the possibilities and proper functions of our different available fuels—coal, wood, peat, oil and gas.

Consumption	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Prince Edward Is.	New Brunswick	Nova Scotia	Grand Totals
Domestic										
Anthracite	10,344	113,180	28,197	1,659	—	—	—	—	—	
Bituminous	1,311,423	1,951,833	140,413	17,719	—	894,944	82,924	881,031	2,826,300	
Lignites	21,183	959,326	1,134,898	79,252	—	—	—	—	—	
Total Domestic	1,343,120	3,024,489	1,302,958	98,629	—	894,944	82,924	881,031	2,826,300	10,701,550
Imported										
Anthracite	—	Small	208,000	325,000	2,242,874	1,794,410	—	Small	Small	
Bituminous	—	Small	718,819	1,827,998	6,459,102	4,174,850	—	—	—	
Total Imported	—	Small	926,879	1,952,998	8,701,976	5,969,260	—	Small	Small	17,580,603
Total Consumption	1,343,120	3,024,489	2,229,835	2,051,627	8,701,979	6,864,204	82,924	881,031	2,826,300	28,282,153
Total Production	2,584,061	4,558,054	281,300	—	—	—	—	143,540	6,812,140	14,480,095
Production over consumption	1,240,941	1,530,565	—	—	—	—	—	—	4,085,840	
Consumption over production	—	—	1,948,535	—	—	—	—	747,491	—	
Consumption no production	—	—	—	2,051,627	8,701,976	6,964,204	82,924	—	—	
	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Prince Edward Is.	New Brunswick	Nova Scotia	

Plate No. 1.—Coal Consumption and Production in Canada

Practically every speaker has indicated their interdependence and their interchangeability of use. It remains for me to demonstrate the relation of "white" coal to all other fuel-power agencies, and to point out that they must all "coalesce" in meeting the fuel-power requirements of the country.

To furnish a quick general summary "bird's eye view" of the "white" and black coal situation in Canada, and to indicate their integrality, I have had several maps and diagrammatic statements specially prepared for submission at this meeting.

Pacific and Atlantic Provinces Self-Sustaining, But Central Provinces Dependent for Coal

Plate No. 1 represents the coal consumption and production in Canada. The tabulated statement on the top of the plate summarizes the consumption in the various provinces of the different classes of coals, both domestic and imported. You will observe the greatest consump-

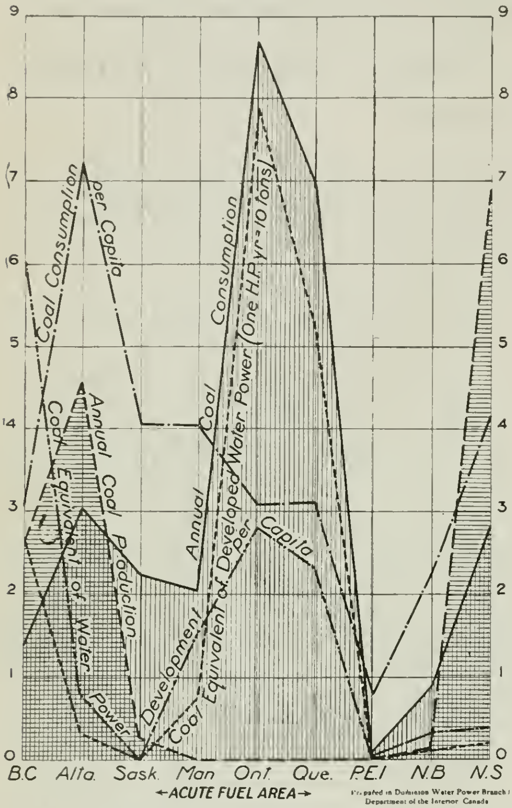


Plate No. 2—Diagrammatic Representation of Canadian Coal Situation

LEGEND

Annual Coal Consumption in millions of tons....
Annual Coal Production in millions of tons....
Annual Coal Consumption per Capita in tons...
Annual Coal Equivalent of Developed Water Power (1 H.P. Year = 10 tons) millions of tons ....
Equivalent Water Power Consumption per Capita in tons ....

tion is in central Canada, including the provinces of Manitoba, Ontario and Quebec. Coal production is greatest in the extreme western and eastern provinces. British Columbia and Alberta on the one hand and Nova Scotia on the other not only meet their own coal requirements, but produce a very considerable overplus for consumption in the contiguous portions of central Canada. The central provinces—Manitoba, Ontario and Quebec—are almost wholly dependent on outside sources, mainly imported coals. This is clearly shown by the hatched areas on the map, the horizontal hatching covering the areas which produce their own needs, the vertical hatching covering the areas which are dependent. Where there is cross-hatching both Canadian and imported coals are consumed. It is to be observed that central Canada, where consumption is greatest, is non-productive. This I have termed the "acute fuel area" of Canada.

An Acute Fuel Area in Canada Largely Dependent on Imported Coal

This "acute fuel area" is now dependent for domestic requirements mainly upon Pennsylvania anthracite and for industrial needs upon Pennsylvania bituminous coals, as well as upon Canadian water power. So far as domestic heating requirements are concerned, Mr. Dick, the consulting mining engineer of the Conservation Commission, in his paper on the "Rational Development of Canadian Coal Resources," has pointed out the possibilities of the western portion of the "acute fuel area" being furnished with briquetted lignite from the prairie provinces. Mr. Stansfield, of the Dominion Mines Branch, in his paper on "The Low Temperature Carbonization and Briquetting of Bituminous Coal," has pointed out the possibilities of meeting the domestic heating requirements of the eastern portion of the "acute fuel area" by the product from the low temperature carbonization of Nova Scotia bituminous coals. Although both these processes are proven to be practicable, they are as yet in their formative or agitational stage and some considerable time must elapse before they can be placed on a commercial basis to furnish sufficient fuel to substitute for any large portion of the Pennsylvania anthracite now imported for domestic heating. There is at the present time no available supply, even in small quantities of a Canadian coal fuel to take the place of imported anthracite. Nevertheless, this "acute fuel area" can eventually be made independent of foreign fuel imports and Canada can become self-sustaining, at any rate, in respect of her domestic heating requirements. There must, as a necessary preliminary, be a national, co-ordinated development and use of all the available fuel and power-producing agencies in the Dominion. Such a co-ordination must be a matter of gradual evolution and adoption, and will, to a great extent hinge on whether Canada can reasonably expect assured fuel imports from the United States for a considerable period in the future.

Canada an Exporter of Electrical Energy

As we are now exporting large quantities of coals from British Columbia and Nova Scotia into adjacent States of the Union, and as we are also exporting about 275,000 horse-power of electric energy, equal in value to about 3,000,000 tons of coal, it is obvious the United States cannot afford to place a sudden and complete embargo on coal exportation to Canada. The two countries must deal with each other, at least, upon a basis of *quid pro quo.* Providing Canada has her own fuel resources under strict national control, this power exportation should assure her an importation of sufficient coal to tide over any readjustment period necessary to permit of an ultimate dependence on Canadian sources of fuel and power.

Exportation of Electrical Energy and Assurance for Fuel Needs

The exportation in the past of Canadian electric energy has not been without compensating advantages. An assured United States market for Canadian power loads has enabled the financing and completion of several hydro-electric projects, the construction of which, so far as do-

mestic markets alone are concerned, would not have been warranted at the time. The initial United States power load has, therefore, made it possible for the domestic market to reap all the benefits of available hydro-electric energy many years sooner than otherwise would have been possible.

While Canada has been receiving far more value in her coal importation than she has given in her power exportation, the advantage is rapidly disappearing. It is reasonable to expect that the tendency will be for hydro-power exportation to increase and for coal importation to decrease. The time may come, and in the near future, when the balance will be against Canada.

It is, therefore, imperative that every proposal for increase in the exportation of power be carefully considered from a broad national standpoint. Such consideration involves the evolution of a formula with regard to power exportations which will have cognizance of Canada's fuel-power needs generally.

We must face the fact that for some time to come we shall require to import United States coal, and that in turn therefor we can, under proper conditions of recovery safely and profitably export some of our surplus hydro-electric energy.

Canada, to Become Self-Sustaining, Must Use All Her Fuel-Power Resources According to Their Particular Adaptability

B. F. Haanel, chief of the fuel testing division, Department of Mines, in his clear and comprehensive paper on the "Fuels of Canada," describes the nature, location and extent of our varied, available fuel resources. Mr. Haanel affirms that, while the problems associated with the distribution of fuel to the various parts of Canada are exceedingly complex and the strictest conservation must be practiced, the Dominion is endowed with fuel deposits on such a magnificent scale that all that is necessary is their proper exploitation and economic use for the country to be eventually practically independent of foreign sources of fuel. Mr. Haanel is particularly emphatic that Canada need not go abroad for fuel for household use, if her own fuel resources are properly exploited.

The problem of Canada's fuel needs outside of the "acute fuel area" offers little difficulty, owing to an abundance of both coal and water power. It is simply a matter of efficient and effective use of available resources. Within the "acute fuel area," however, the problem is pressing and prodigious. It resolves itself into two parts; first, provision for domestic or household heating consumption, second, provision for industrial requirements.

1—Domestic requirements of "acute fuel area" involves production of suitable substitute for anthracite.

Domestic needs involve the production of a fuel or fuels which will meet the requirements for general household use. At the present time this need is furnished by American anthracite; over 4,000,000 tons were used in 1916. Competent experts declare the anthracite coal fields of the United States are in measurable distance of exhaustion and that the supply will not last a hundred years. Having in mind the ever-increasing demands within their own borders for this fuel and the rapid decrease in quality as the supply becomes exhausted, responsible fuel advisers of the United States government have seriously urged the establishment of an embargo against exportation of anthracite. We in Canada must realize that our supply of this fuel may be gradually restricted. It is, therefore, essential that we, without delay, consider what can be accomplished in the production of a suitable substitute for United States anthracite.

2—Industrial requirements of "acute fuel area" involve (*a*) more efficient use of soft coal in central heating stations, (*b*) construction of super-power plants to serve contiguous industrial areas, (*c*) substitution of hydro power for steam-produced power wherever possible, (*d*) use of hydro power for all new industries wherever practicable.

The second part of the "acute fuel area" problem and the one with which water power is most intimately connected is the fuel necessity of the industrial or manufacturing world.

The industrial requirements are now met by Canadian hydro power and United States bituminous coal—about 14,000,000 tons consumed in 1916 for this purpose in the "acute fuel area."

Owing to the large reserves of bituminous coal in Pennsylvania, this class of fuel will probably be available

WATER POWER IN EUROPE AND NORTH AMERICA

Dominion Water Power Branch Estimate 1915 (slightly revised)

Country	Area Sq. miles.	Population latest available figures.	H.P. Available	H.P. Developed	Per cent utilised	H.P. Available per sq. mi.	H.P. Developed per sq. mi.	H.P. Per Capita Available	H.P. Per Capita Developed
U.S.A.	2,973,890	98,783,300	28,100,000	7,000,000	24.9	9.4	2.35	0.28	0.071
Canada 'A'	2,000,000	8,033,500	18,803,000	1,735,000	9.2	9.4	0.87	2.34	0.216
Canada 'B' Populated	927,800	8,000,000	8,094,000	1,725,000	21.3	8.7	1.86	1.01	0.216
Austria-Hungary	261,260	51,173,000	6,460,000	566,000	8.6	24.8	2.17	0.13	0.011
France	207,500	39,601,500	5,587,000	1,100,000	11.6	26.5	3.14	0.14	0.016
Norway	124,130	2,391,730	5,500,000	1,120,000	20.4	44.3	9.02	2.30	0.468
Spain	190,401	19,588,700	5,000,000	440,000	8.8	26.3	2.31	0.26	0.022
Sweden	172,960	5,522,400	4,500,000	704,500	15.6	26.0	4.08	0.81	0.127
Italy	91,400	28,601,600	4,000,000	976,300	24.4	43.5	10.7	0.14	0.034
Switzerland	15,976	3,781,500	2,000,000	511,000	25.5	125.2	32.0	0.53	0.135
Germany	208,800	64,926,000	1,425,000	618,100	43.4	6.9	2.96	0.02	0.010
Great Britain	88,729	40,831,400	963,000	80,000	8.3	10.9	0.91	0.02	0.002

Plate No. 3—Water Power in Europe and North America

to the "acute fuel area" of Canada for many years. Although not immediately necessary, the ultimate substitution of bituminous coals must, nevertheless, be seriously considered. Water power will be the main means of such substitution. The industrial fuel problem, therefore, in the "acute fuel area" becomes largely a matter of substitution of hydro power for fuel power.

Electrification of railways, especially terminals with adjacent engine divisions, would save enormous consumption of bituminous coal and relieve our transportation systems of their greatest burden.

It is estimated that something like 9,000,000 tons of coal was consumed by our railroads in the year 1917. Judging from the results obtained from the electrical operation of railroads in the United States, it would be possible to save at least two-thirds of this coal if electric locomotives were substituted for the present steam locomotives. This would be a saving of 6,000,000 tons of coal in one year, and would require about 900,000 water horse-power.

Electrification of steam roads at this juncture is not advocated. Under normal conditions, however, and in certain districts, as in western Ontario, electrification will become an economic necessity in a few years.

In districts that cannot be served by water power, the location of modern, efficient, super-power stations at strategic points, with a resultant elimination, or combination, of many inefficient, small stations, would cause a very large saving in the consumption of soft coal, with a concurrent increased production of power.

The substitution in industry generally of hydro power for steam fuel power, would also result in a tremendous relief. There are many plants where such an exchange would be possible now. Future manufacturing plants

should be encouraged to locate where hydro power is available.

Water power must be depended upon very largely to serve the industrial fuel-power situation in the "acute fuel area" of Canada.

The relation between developed water power and the coal production and consumption in the various provinces is represented on Plate 2. It is interesting to note that in the "acute fuel area" there is about as much water power developed, so far as coal value is concerned, as there is coal consumed. It is portentous that the bulk of our water power production at the present time is within the "acute fuel area," and it is reassuring to know that our largest and most important potential water powers are located within transmission range of present congested industrial districts within the "acute fuel area."

Canada is Exceedingly Fortunate in the Extent and Location of Her Water Powers

When considered in retrospect, the production of hydro power in Canada has undoubtedly been an industrial achievement and an engineering triumph worthy our nation. In the short space of about twenty-five years, there has been developed and put in use, nearly 1,800,000 water horse-power. A tabulated statement (see Plate No. 3) of the water power development in other countries, compiled recently from all available data, shows the universal importance of this resource and indicates the splendid comparative position Canada enjoys in both potential and developed water power. The present per capita power development in Canada is larger than all other countries except Norway. It is the same with respect to our known undeveloped water power. No country enjoys to a greater degree the benefits of cheap, dependable hydro power, and no country has had these benefits more universally applied for municipal, industrial and domestic use. That Canada is recognized as one of the great water power countries in the world is due largely to:

(1) The nature and extent of our water resources—abundance and seasonable distribution of rainfall; the regimen of our rivers—upper waters well forested with large lakes, suitable for regulation—rivers flowing through valleys with well concentrated falls.

(2) The fortunate location of the waterfalls with respect to existing commercial centres, and related raw materials.

(3) The consistent endeavors of governments, Dominion and provincial, in having water powers thoroughly investigated and intelligently administered.

(4) The business acumen and foresight of the capitalist, and the professional skill and courage of the engineer, in blazing the trail of pioneer water power development and use.

(5) The almost universal adaptation of electric energy for municipal, industrial and domestic purposes.

Fortunate Location of Water Powers

The outstanding feature of the water powers of Canada is their fortunate location with respect to existing commercial centres. Within economic transmission range of practically every important city from the Atlantic to the Pacific, except those in the central western prairies, there are clustered water power sites, which will meet the probable demands for hydro power for generations. The following table, prepared by the Dominion Water Power Branch, indicates, reasonably accurately, the provincial distribution of the developed and undeveloped water powers within the settled portions of the Dominion.

Province.	Power available.	Power developed.
Ontario	5,800,000	789,466
Quebec	6,000,000	520,000
Nova Scotia	100,000	21,412
New Brunswick	300,000	13,390
Prince Edward Island	3,000	500
Manitoba	} 3,500,000	76,250
Saskatchewan		100
Alberta		32,860
British Columbia	3,000,000	269,620
Yukon	100,000	12,000
Total	18,803,000	1,735,598

Small Portion (Not 10 Per Cent.) of Canada's Available Water Powers Developed

In general, the use of water power in Canada may be briefly described as follows:—

(*a*) For municipal, including domestic and ordinary industrial purposes, about 78 per cent. of total developed or 1,348,490 horse-power.

So far as these uses are concerned, further requirements will probably be met for some years by additional installations at, and increased storage for, existing plants. In certain centres, however, as for instance the Niagara power zones, growing requirements can only be met by new water power developments.

(*b*) Pulp and paper, about 14 per cent. of total developed or 248,075 horse-power.

Further pulp and paper plant requirements can probably be met for some time by additional installations to present plants, although the tremendous growth of this industry will necessitate the development of new water powers in different parts of the Dominion. There are now 54 pulp and paper plants scattered throughout Canada and several new plants have been under serious contemplation, some of which would be in use now had it not been for the difficulty of financing due to war conditions.

On account of the isolated nature of the industry—away from commercial centres—power requirements for pulp and paper need not conflict with other demands upon hydro power.

(*c*) Electro-chemical and similar processes, about 8 per cent. of total developed, or 140,000 horse-power.

While the United States have achieved almost a world supremacy in electro-chemistry, this industry in Canada is of very recent growth. It has, however, expanded at an enormous rate, entailing recent extensive additional installation in present plants, and requiring in the near future the development of additional water power sites. Our propinquity to the United States, and our abundance of essential raw material will compel the migration to the Dominion of many new electro-chemical plants of importance and value.

The products of the electro-chemical industry are extremely diversified. They include aluminum, silicon, calcium-carbide, cyanamid, ferro-alloys, graphite, carborundum, chlorine, etc., many of which are indispensable in the arts and in manufacture. Without aluminum the modern high-speed scout airplane would not exist; without electro-chemical abrasives and ferro-alloys manufacturing processes would be lengthened many-fold. Our industrial supremacy in times of peace is dependent upon these products to a very considerable extent.

One of the most important electro-chemical processes is the fixation of nitrogen. About 30,000 h.p. is used for this purpose at Niagara by the American Cyanamid Com-

pany, and while other plants of this kind have so far not been put into operation commercially in this country, they have been seriously contemplated, and await only a sufficient source of low-price power for realization.

The electro-metallurgical industry is in its infancy, but promises great expansion, especially in the production of nicu-steel in Canada. Few people appreciate the rapid growth during the last two years in the use of electric furnaces for the production of the highest grades of steel.

By proper foresight the demand for hydro power for these industries need not conflict with other demands, as, for instance, municipal, domestic and ordinary industrial uses.

Total developed power, about 1,735,598 h.p.

Further Use of Hydro-Electric Power

In considering the future of water power development in Canada, it is important to note that it means the use of a non-expendible resource, and in many cases represents the substitution of an inexhaustible resource for an exhaustible one. For this reason, the use of hydro-electric energy should be encouraged in every reasonable way.

Further development of water power in Canada will, undoubtedly, be extensive and must depend very largely on:

(1) Additional requirements for municipal, industrial and domestic use.

(2) Growth of pulp and paper industry.

(3) New electro-chemical and electro-metallurgical processes.

(4) Electrification of steam roads, especially terminals and adjacent engine divisions.

(5) Substitution of hydro-electric power for fuel power in manufacturing and industry.

In the rapid development within a short space of time of our water powers to the extent of nearly 1,800,000 horse-power, it is natural to expect that there has been some misconception in design, in construction, in conservation of opportunity, in overlapping of service, and even in governmental administration, although as to the latter it is an axiom in British jurisprudence that "the King can do no wrong." If we were starting *de novo* to develop our water powers, with our present knowledge of what is essential in government investigation and administration, of what is really basic in conservation of resource, of the present practice of the art of hydraulic and electric engineering, and last, but by no means least, of what is the most important or prior market demand, from a national standpoint, from particular power sites, whether general municipal requirements should precede electro-chemical and allied industrial requirements, we would, for instance, most assuredly produce a very different power situation at Niagara. At the same time, this most important and world-famous source of our electric energy has well served us. Generally speaking, our water powers have undoubtedly proven to be one of Canada's most valuable assets.

Looking to the future in power development, if Canada is to reap full benefit from her heritage in white coal, there must be a constructive liaison between (*a*) the various Dominion and provincial government administrative departments concerned in water power matters; (*b*) the producing corporation or commission, and (*c*) between the consuming public. Concurrently with such a liaison there must also be an adequate co-ordination of the development and use of water power with that of all other power-producing agencies.

Anyone who has listened attentively to the very able presentation of the various elements in the fuel situation during the last two days, must realize that there is a prodigious field for such co-ordination in the development and use of our varied power and heat-producing resources which will combine the effective use of all, along lines for which each is best adapted, and which will, by avoiding duplication or misdirection of effort, promote the efficiency of both individual and conjoint use.

The necessity for the correlated development and use of all our fuel-power resources has surely passed the agitational or educational stage. The many urgent reasons for such correlated use are stressed a hundred-fold by the coal shortage experience of this winter.

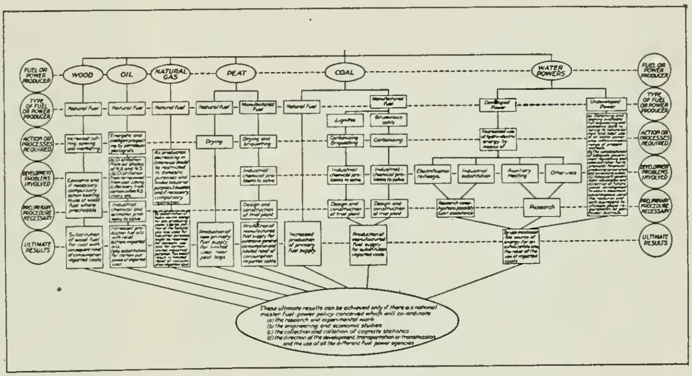


Plate No. 4—The Fuel-Power Resources of Canada

To visualize the interdependence and interrelation of all the fuel-power agencies available in Canada, and to offer something as a basis for general discussion, I have prepared a chart (Plate No. 4), which if it indicates any one thing it conclusively proves the immensity and complexity of the problems involved in effecting the co-ordinated, concomitant development and use of all our fuel-power resources. The chart shows that this can be best realized following the evolution of a national master fuel-power policy for all of Canada.

Gentlemen of the Canadian Society of Civil Engineers, are we going to leave this great problem in "the laps of the gods"? It is not one of peculiar concern to engineers, and of such timely and pressing importance to Canada that we, as a society, would be warranted in attempting a solution? Should we not mark the enlargement of the scope, influence and prestige of our society (which, we hope, is being exemplified by its transition to the Engineering Institute of Canada) by an earnest effort to evolve, in general terms, the basic principles of a national master fuel-power policy for Canada?

Cheap power promises to be one of this country's greatest assets in the post-bellum industrial rivalry of nations for world trade. Our great fuel reserves, supported by our water power resources, represent a sure source of cheap power, and should guarantee Canada her share in world trade, if our varied fuel-power resources are availed of to their maximum possible advantage.

THE GREATER WINNIPEG WATER DISTRICT

By C. S. C. Landon, A.M.Can.Soc.C.E.

THE Greater Winnipeg Aqueduct ranks as a major engineering undertaking, the scheme in the main consisting of the bringing of water from Indian Bay, a part of Shoal Lake, which is an arm of the Lake of the Woods. The water will be delivered to the city of Winnipeg and to the surrounding municipalities. This is to be accomplished by means of gravity flow, taking advantage of a difference in elevation of about 300 feet, the distance between the two points being 96.5 miles.

The question of a suitable water supply had been for some time a vexed one, both because of the uncertainty of quantity of the supply and because of the quality of the water. The purity of the present supply for domestic purposes is unquestioned, and is rarely equalled in public water service, but because of the extreme degree of hardness a great deal of expense is incurred not only by corporations and manufacturing industries, but also by individual consumers. Those controlling power plants are called on to make frequent renewals of steam and water fittings and to expend large sums for water softeners and scaling compounds while the householders must necessarily regularly renew water fronts in stoves, coils in water-heaters and fittings in heating systems, owing to the corroding and incrusting elements in the water of the present supply.

A board of consulting engineers composed of Messrs. Rudolph Hering, Frederic P. Stearns, and James H. Fuertes, was appointed and on May 20th, 1913, received the following instructions from the city council:—

"That the Board of Consulting Engineers be instructed to submit a report on the best means of supplying the Greater Winnipeg Water District with water from Shoal Lake, together with estimate of cost and general plan of the work."

After an exhaustive study of the question the consulting engineers reported as follows:—

"Shoal Lake, without help from the main Lake of the Woods, can be depended upon to furnish, even in the driest years, a large part, if not all, of the water needed for Winnipeg until the population shall have reached about 850,000, and with the help of the Lake of the Woods can furnish a practically inexhaustible supply.

"The water of Shoal Lake was, when we examined it, of excellent quality for domestic and manufacturing purposes, being soft, practically free from contamination, without noticeable color, free from odors and of an agreeable taste. The results of recent examination of the Shoal Lake water, and all of the local conditions, indicate that the occurrence of bad tastes and odors in the water, from growths therein, should be infrequent, and may never occur at all."

Should such troubles occur in the future the opportunity to correct them by suitable treatment may be availed of when necessary without interrupting the supply of water to the city or making expensive changes in the works as built.

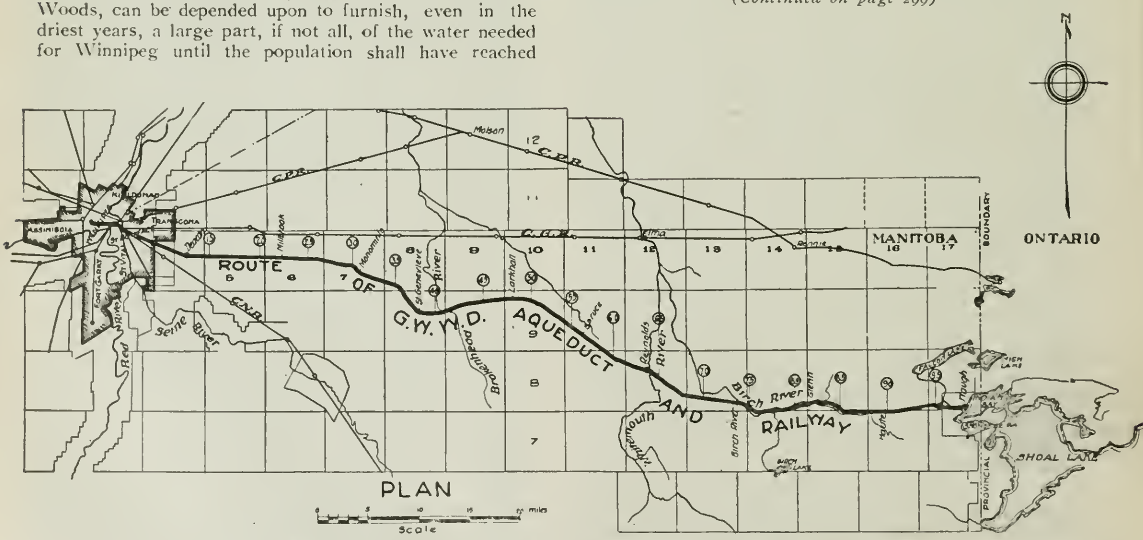
"The best point to take the water is from near the west end of Indian Bay, an arm of Shoal Lake, as the depth of the water and the configurations of the bottom and shores in this neighborhood are favorable.

"In order to avoid the dark colored water discharged by Falcon River, and cut off the shallow flowage at the extreme westerly end of Indian Bay, we propose the construction of a dyke across the end of the bay and a canal leading therefrom to Snowshoe Bay, through which to divert the undesirable waters.

"We find that the best way to get Shoal Lake water to Winnipeg is to bring it down first through a concrete aqueduct 84.75 miles in length, laid with a continuous down grade to a point about a mile east of Transcona, and then in a 5-foot steel pipe to the Red River. A 5-foot cast-iron pipe, in tunnel, is to convey the water under the river, and thence a 4-foot cast-iron pipe, laid in the city streets, will deliver it to the reservoirs at McPhillips Street. The total length of the aqueduct is 95.35 miles.

"We recommend that the concrete portion of the aqueduct be given a capacity of 85,000,000 Imperial gallons per day, but that the pipe line portion be given the smaller sizes above stated, capable of discharging 25,000,000 gallons per day by gravity into the McPhillips Street reservoirs.

(Continued on page 299)



Plan of Greater Winnipeg Water District Aqueduct, Railway and Surrounding Country from Shoal Lake to Winnipeg

RAILWAY ELECTRIFICATION*

By John Murphy

Chief Electrical Engineer, Department of Railways and Canals.

NOTE.—The writer wishes to acknowledge his indebtedness and to publicly return his thanks to officials of the railways below-mentioned, and of the manufacturers of the apparatus referred to, as well as to the technical press, from which much of the following material has been gleaned.

STILL smarting from the sufferings of two successive winters' fuel shortages, caused by inadequate transportation facilities, we are foregathered to see what can and should be done to prevent, if possible, recurrences of such serious and trying experiences.

No argument is required, I think you will agree, to support the contention that eliminating the need for coal at a considerable distance from the mine is a greater measure of relief, and of true conservation, than increasing mine production and thereby incidentally adding more load to the already overburdened railways. Reducing coal consumption automatically relieves or releases men and apparatus all along the route from the mine to the consumer; it also relieves the route itself from some of its congestion.

So eminent an authority as E. W. Rice, the president of the American Institute of Electrical Engineers, addressing that body in New York last month, made the following statement:—

"It is really terrifying to realize that 25 per cent. of the total amount of coal which we are digging from the earth is burned to operate our steam railroads—and burned under such inefficient conditions that an average of at least 6 pounds of coal is required per horse-power-hour of work performed. The same amount of coal burned in a modern central power station would produce an equivalent of three times that amount of power in the motors of an electric locomotive, even including all the losses of generation and transmission from the power station to the locomotive."

Mr. Rice went on to say that 150,000,000 tons of coal, nearly 25 per cent., of all the coal mined in the United States, were consumed in steam locomotives last year.

Here in Canada, steam locomotives also did their bit and consumed about 9,000,000 tons—30 per cent. of the 30,000,000 tons of coal imported into and mined in this country. Our 9,000,000 tons cover, I believe, wood and oil consumed on steam locomotives; some 49,000,000 gallons of oil are covered by the Canadian record. But in the United States figures, 40,000,000 barrels of oil (15 per cent. of the total output) are not included.

The conservation of—the elimination of the necessity for mining—those great quantities of fuel would be secured if all the railways were operated electrically, and if the electrical energy were generated from water power. Modern steam central stations would save from 50 per cent. to 66 per cent. of the coal now used in steam locomotives if the latter were discarded and electric locomotives used instead.

With such possibilities for fuel conservation in sight may we not soon expect to learn that the fuel controllers in both countries have asked the railways, and that the railway managers have asked their engineers: "How many of these millions of tons of coal can you save? When will the good work begin?"

It is said that our fuel shortages were due to a combination of bad weather and inadequate transportation. As we cannot control the weather our attention and efforts must be directed to the transportation portion of the difficulty. Railway electrification will reduce coal consumption and haulage; it will also greatly improve traffic conditions. Electrification, therefore, seems to be the solution of the problem. Under these circumstances it may not be out of place to recite in general terms what electrification has actually accomplished on some notable railways.

Railroading in the mountains is the most strenuous kind of railway work. The examples which I have chosen cover mountain sections. The Butte, Anaconda and Pacific Railroad, by electrification, increased its ton-mileage 35 per cent. and at the same time decreased the number of trains, and their incidental expenses, 25 per cent. The time per trip was decreased 27 per cent. It is said their savings in the first year's operation, after electrification, amounted to 20 per cent. of the total cost of electrification. They buy power from water power plants.

On the Norfolk & Western Railway, power is obtained from their own steam station. Twelve electric locomotives have replaced 33 Mallets of the most modern and powerful type. The tonnage has been increased 50 per cent. Electrification obviated the necessity for double-tracking. The salvage value of the released steam engines was 45 per cent. of the cost of electrification. Electric locomotives make eight times as many miles-per-train-minute-delay as the steam engines. Their terminal lay-overs average 45 minutes and they are double-crewed every 24 hours. Pusher engine crews have been reduced from eight steam to four electric. Pusher engines or locomotives have been reduced from seven steam to two electric. Steam locomotives used to "fall down" in cold weather—the electrics always "stand up," are really more efficient in cold weather. At the New York Railroad Club meeting last year their electrical engineer stated that "coal wharves, spark pits, water tanks and pumps, as well as roundhouses and turntables, have all disappeared from the electric zone. Our track capacity has been doubled. Our operating costs have been reduced. From an engineering, an operating and a financial viewpoint our electrification has been a success." Speaking of the value of the regenerative electric braking of their system, he went on to say: "The use of the air brake is practically eliminated; it is only used to stop trains. It is regrettable we are unable to put a dollars and cents value on this great asset; to appreciate it properly one must have had experience with the difficulties of handling 90-car trains with air." Another official, referring to the same subject, made the following statement: "Trains of 103 cars are taken over the summit twelve to twenty times every day, down the 2.4 per cent. grade, without ever touching the air. We never broke a train in two or slid a wheel. It is done so nicely we wouldn't spill a drop of water out of a glass in the caboose."

The 440 route miles of the Chicago, Milwaukee & St. Paul Railway which have been electrified will soon be augmented by 450 miles more. Nearly 900 route miles and about 33 per cent. in addition for passing tracks, yards, industrial tracks and sidings will soon represent the extent of this great railway electrification. Among the advantages secured by this railway on its electric sections are the following: The cruising radius of each electric locomotive is twice that of the steam engine. Subdivisional points, where freight crews and steam locomotives were formerly changed, have been abolished; the passenger crews' runs are now 220 miles instead of 110. For railway purposes, these stations do not now exist; seven or eight miles of track have been taken up; through freights do not leave the main line track at all; shops and

*Paper read before the first general professional meeting of the Canadian Society of Civil Engineers, held at Toronto, March 26-27, 1918.

roundhouses have disappeared along with their staffs, and one electrician replaces the whole old force. An electric locomotive has made 9,052 miles in one month. Although schedules have been reduced the electrics have made up more than two and one-half times as many minutes as steam engines—time which had been lost on other divisions; 29 per cent. of electric passenger trains made up time in this manner. On a mileage basis alone the operating costs of the electrics are less than one-half the steam engine costs. Freight traffic increased 40 per cent. shortly after electrification—double-tracking would have been necessary to handle such increased business under steam operation. An average increase of 22 per cent. in freight tonnage per train has taken place. One electric handles about three and one-half times as many ton-miles as a steam engine; the reduction in time in handling a ton-mile is 30 per cent.; faster and heavier trains have accomplished these results, the number of trains has not been increased. About 11½ per cent. of the energy used by the railway is returned to the line in the process of regenerative braking and this returned energy helps to haul other trains. While this is a very important item and reduces the power bills, it is only regarded by the management as of secondary importance in comparison with the more safe and easy operation of trains on the grades and the elimination of former delays for changing brake shoes and repairs to brake rigging, when operating with steam locomotives.

The electrics maintain their schedules much better than steam engines. In three months the electrics only waited for the right-of-way 254 minutes, while the steam engines in a similar period waited 1,910 minutes, or seven and one-half times as long. Extra cars on trains only delayed electrics one-ninth of the time steam trains were delayed for a similar reason. Cold weather delayed steam trains 445 minutes in the three months under discussion, but the electrics were not delayed a minute; the latter are more efficient in cold weather. Many of the delayed steam trains were double-headers—never more than one electric is hitched to a passenger train. An entire suspension of freight service, due to steam engines losing their steaming capacity and freezing up was not an uncommon experience. Electrical energy for the operation of these trains costs considerably less than coal. This latter statement is one of the most interesting in connection with the operation of the C. M. & St. P. Railway and it is especially interesting because it was made more than one year ago.

The foregoing experiences of men who are actually operating large railway electrification projects, show what the electric locomotive is doing every day. As the vice-president of the last-mentioned railway said, "Electrification has made us forget that there is a continental divide."

The limitations of the steam locomotive are due to the fact that it is a mobile steam power plant of very limited capacity, compelled to carry its own supply of coal and water, and unable to take advantage of many of the economical refinements of the large modern stationary steam plant. On the other hand, the electric locomotive has no such limitations. It merely acts as a connecting link between efficient gigantic stationary steam or water power plants and the train to which it is connected. The "Electrical World" summed up the situation a short time ago when it said: "Why continue to haul millions of tons of coal, for and by uneconomical steam locomotives, all over the country, and thus add more loads to the already over-burdened railways, when the power which they need so badly can be much more economically and efficiently transmitted to electric locomotives over a wire the size of one's little finger?"

The continual increasing cost of coal and fuel oil will force railway managers to look more and more carefully into railway electrification. Estimates of a few years ago now need revision. Money may be hard to get, but if, at times, fuel cannot be obtained at all, some substitute must be obtained if normal life is to be continued in northern latitudes.

A representative of the National City Bank of New York, writing of the period after the war, referred to the stagnation which may ensue in all the great industries now engaged in war work as soon as peace is declared; the multitude of people thus thrown out of work in addition to the men of the returning armies would create unbearable conditions unless suitable employment will have been arranged for them in advance. He referred to the economic advantages of railway electrification and was of opinion that this work might solve the whole question if soon taken up with vigor.

The Minister of Public Works, Hon. F. B. Carvell, M.P., addressing the Ottawa branch of our organization a couple of weeks ago, spoke of the necessity of conserving the energy of our water powers—instead of letting them run to waste—so that this great store of energy might be employed in assisting to build up our own and rebuild other countries when peace comes. How nicely these two ideas, water power development and railway electrification, work together if properly carried out.

With the view of securing something really worthy of presentation to this important meeting, I recently wrote an eminent engineer, a man of international fame, and recognized as an authority on railway electrification, requesting him to tell me his own views upon this subject. A specialist's opinion, in my opinion, is always very valuable. Here is a short extract from his interesting reply: "Generalization is always dangerous, especially in connection with electrification of railways, where so many factors such as the physical location, character of loads, the power situation, etc., come in to affect the decision if applied locally." From his sober statement it may be seen that my correspondent is an engineer, not a politician. He proceeded as follows: ". . . with present equipment-prices, the cost is absolutely prohibitive." This opinion, let me point out, is in connection with the proposal to "electrify everything." Do not let it dampen our enthusiasm. Listen to this also and kindly keep it in mind; it is another extract from the address of E. W. Rice, above referred to. He said: "I think we can demonstrate that there is no other way known to us by which the railroad problem facing the country can be as quickly and as cheaply solved as by electrification."

While the present fuel shortage questions have made us look to railway electrification for relief, I feel such a project on a large scale can only follow or go hand in hand with power plant development and co-operative operation of power plants. The location of a number of plants at different points—large water power plants and auxiliary steam plants—so situated and inter-connected that a failure at one plant or the connections to it will not jeopardize the others or completely cut off and isolate an important railway district is, in my opinion, an essential feature in connection with any large railway electrification project.

The 99-year contract of the Chicago, Milwaukee & St. Paul Railway is worthy of more than a moment's attention and consideration in this discussion. That railway has a contract with a power company which has a series of plants stretching across the country parallel to the railway. The railway owns its sub-stations and

secondary lines, but is not concerned with the high-tension lines or power plants of the power company. A reasonable rate for power, arranged between a willing purchaser and a willing seller—a contract, in fact, which each party knows the other will respect—is the basis and the real reason for that great railway electrification. Neither party questions the other's integrity or financial soundness. One delivers the power it has undertaken to supply and the other uses it. The arrangement is ideal in its simplicity and entirely satisfactory to everybody concerned. It will, in my opinion, be necessary to have such attractive power-supply situations as those outlined above, backed by abundant supplies of power, in order to foster and encourage early railway electrification work in this country.

Railway electrification is, in my opinion, a very pressing financial, economic and engineering problem—a problem worthy of the best attention of the most highly trained and experienced specialists.

THE AIR-LIFT PUMPING SYSTEM

By A. W. Swan
Canadian Ingersoll-Rand Co., Limited

TWENTY-FIVE years ago Dr. Julius Pohlé made his first successful experiments on pumping from deep wells, using compressed air, and the air-lift system as it is to-day is, with the exception of detail in design, the same as the Pohlé. Contrary to what one might expect, the compressed air is not used to force the water upward; air is led downward in the well and released in the rising main. Here the compressed air mixes thoroughly with the water and forms a froth, which, being lighter than the body of water in the surrounding rock, is naturally forced upward. All that is necessary for an air-lift system is an air compressor—which is housed, of course, in an engine room which may be any convenient distance from the well, an air pipe and a delivery pipe. It is evident that the air-lift system is simplicity itself—and it has other advantages.

In city water supply the problem of filtration is acute; slow sand filtration is expensive to instal and maintain, and at the best does not absolutely sterilize the water, and for complete sterilization the unpleasant chlorine process or the expensive ozone or ultra-violet ray process must be installed. It is well known that aeration of water has a strong sterilizing effect, and the city of New York has installed special aerating ponds as part of the Catskill project. Now, in the air-lift system aeration is entirely automatic, and as the water and air flow upward impurities are thrown off. That this is no mere claim is shown by the case of the Asbury, N.J., waterworks, where the air-lift rendered iron-impregnated water as clear as spring water.

Although the principle of the air-lift system is simple, it does not follow that careful design is not necessary. In the earlier Pohlé pumps the air was admitted to the water pipe by a simple bend in the air pipe. However, it was discovered that the chief cause of loss of efficiency in the air lift was air-bubble slippage; the larger the bubbles the greater the loss in efficiency. Hence, design tended to the improvement of the mixing chamber, and in the standard air-lift pumps of the present day, this mixing chamber is carefully designed to divide the air into very fine streams, thus preventing the formation of large bubbles.

Owing to the fact that in the well proper there are only the two pipes, for air and water, the capacity of flow is limited only by the capacity of the well, and as there are no moving parts in the well, wear and depreciation are almost negligible where they would be greatest with the plunger type of pump. Further, one compressor can be used to supply the air for several wells, and the flow of water is regulated from the power house by controlling the air pressure. Among other advantages of the air-lift system may be mentioned the fact that sand or gravel have no effect on the operation of the pump, being simply carried along with the air and water and deposited at the top of the well. The scouring action of the pump in removing sand or gravel generally increases the flow by widening the area from which water is drawn.

In respect to economy, this varies with the size of installation and submergence. Larger installations are, of course, more economical, and for a flow over 300 gallons a minute the air-lift pump will usually be less expensive than the plunger type. In the case of smaller pumps, the actual cost will be about the same for the two types, provided there is sufficient submergence for the air-lift pump. By submergence is meant the ratio of the depth of the mixing chamber below the pumping water-level to the total height pumped. The air-lift is not advisable where the submergence is below 35 per cent., and the best condition for this type of pump is from 45 per cent. to 60 per cent. submergence. The actual cost runs from 1¼ to 2 cents per thousand gallons pumped. The air pressure necessary to run an air-lift pumping system is steady once the water has started to flow, but some provision should be made for extra pressure to start the pump. According to Kent, the compressor should provide one cubic foot of air for each gallon and a half pumped, but this will vary with the depth of the well. Kent also gives the formula $A = \frac{LC}{16,824}$ where A = cubic feet of air, L = lift, C = cubic feet of water pumped.

The air-lift is not very well adapted to pumping horizontally, owing to the fact that the air tends to separate from the water and collect along the top of the pipe. Hence, where water is to be pumped from the top of the well a "booster" is used. This consists simply of a tank in which the air is separated from the water, the pressure of the air being used to pump the water on the rest of its journey by displacement.

In addition to pumping water, the air-lift has a wide field of application for pumping acids, brine, pulp, etc. In ore-leaching, the air-lift has been used to great advantage, and in some of the western oil fields oil has been pumped by this method from wells 800 feet deep.

The February statement of Southern Canada Power Company, Limited, gives gross of $39,326, an increase of $6,368, and net of $18,235, an increase of $3,382. For the month of the current fiscal year gross earnings at $194,860 are $41,518 higher than in the previous year, and net at $88,103 are $11,284 higher

During the first half of last year 289,000 tons of steel were produced in Japan exclusive of her colonies. The largest producer was the Government Steel Works, with 200,000 tons. The Japan Steel Tube Company came next with 22,000 tons, and the Japan Steel Works with 14,000 tons, while the two smallest producers, the Kawasaki Dockyard Company and the Kamaishi Steel Works, turned out 12,000 and 10,000 tons respectively. It is estimated that the year's output of those mills will reach at least 570,000 tons, an increase of 50 per cent. over 1916.

ACTIVATED SLUDGE DEVELOPMENTS

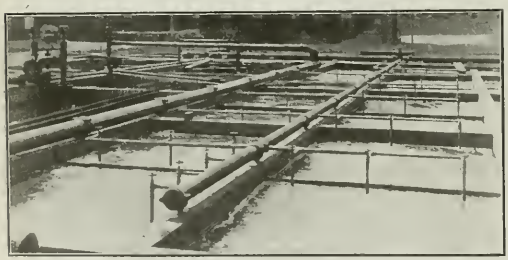
THE Manchester (England) Corporation have approved of a scheme for converting part of one of their large settlement tanks at Davyhulme, Manchester's main sewage outfall works, into an activated sludge tank capable of treating a million Imperial gallons per day of strong sewage.

The activated sludge plant at the Withington outfall, which was designed to treat 250,000 gallons of sewage per day, was first put into operation last September, and the new features introduced, including the Clifford settling tank inlet apparatus, have so far exceeded expectations

View Across Activated Sludge Plant; Settlement Tanks in Foreground

that the volume treated had reached 400,000 gallons per day early in January and is still being increased. Both the Davyhulme and the Withington works are in charge of E. Ardern, M.Sc., who has been so intimately linked with the development of the activated sludge process from its early stages. Both the Davyhulme and the Withington installations are fitted with Jones and Atwood equipment.

The Worcester (England) Corporation have applied to the minister of munitions for a permit to extend their sewage works for the purpose of putting into operation an option given them by Jones & Atwood, Limited, when the original contract for activated sludge plant was signed to extend their plant to treat 3,000,000 gallons per day.



Aeration Tank in Use at Worcester, England

The first trial plant for dealing with 750,000 gallons per day has now been in operation since April, 1916, and Mr. Caink, the city engineer of Worcester, wrote a letter to the Royal Sanitary Institute meeting held January 12th, 1918, to the effect that "The installation of the process at Worcester has in every respect fulfilled my expectations."

UNIFORM ROAD ACCOUNTING*

By Edward N. Hines
Chairman, Board of County Road Commissioners, Wayne County, Michigan.

IN advancing a plan of obtaining costs on highway construction and maintenance, there are certain features which must be noted as essential in order to arrive at dependable costs.

First in importance is the adoption and use of a satisfactory means of controlling the items of labor and materials as they enter into the construction of the road.

Second in order is the division of the work into such groups as will agree most naturally with the character of operations performed, and at the same time readily admit of a classification which will apply to road work in general.

Finally, it is necessary to provide means for checking the results on the various operations during the progress of the work—in other words, to obtain cost figures on the different portions of the work in time to cut off waste and speed up efforts where necessary on the balance of the work still remaining.

As a means of controlling the labor item, the first detail to be considered is the use of the workman's time card. The timekeeper on the job is made responsible for the issuing of one of these cards every payroll period for each man on the payroll. He must record thereon daily the nature of the labor performed and the number of hours in each case, and at the end of the weekly period summarize in the proper space the total hours spent by the man on each class of work. After being approved by the foremen, all the cards thus made up are sent into the main office where the rates are verified, the extensions proven and the amounts due each man entered on the payroll distribution sheet. From this payroll sheet the total labor is distributed to the construction cost ledger and maintenance and indirect expense accounts.

In controlling the stock used in connection with road construction, provision is made for charging each item of material as it is used. All material which on its receipt is used directly on the road without any attempt at storage is charged directly from the voucher record through the distribution ledger to the road in question. To take care of materials, supplies and repair parts which are carried in stock, a series of stores accounts are set up. These stores accounts cover separately the different types of materials used in road construction and are made up as follows: Tiling, brick, cement, pebbles, sand, limestone, granite, trap rock, tarvia, gravel, road oil, armor plate, expansion felt, spiling lumber, coal and general stores. As a means of controlling the issuing of stock from these stores, a suitable form of stores requisition is used. This requisition is issued in triplicate, one copy being retained by the foreman having authority for its issuance; the second copy is kept by the storekeeper having charge of the stores, while the third copy is sent to the main office. This third or office copy is authority for charging the material in question to the proper account through the transfer journal. The operation of such a plan of stores control naturally requires the supervision of this stock by a competent storekeeper with adequate space and suitable conditions for proper storage.

*Abstracted from paper presented at the fourth annual short course in highway engineering at the University of Michigan, February 25-March 1. 1918.

FUEL FROM A TRANSPORTATION STANDPOINT*

By W. M. Neal
Canadian Railway War Board

No gentleman in this room needs to be reminded of the close and intimate connection between the humble coal pile in his cellar and the pride and comfort of the loftier apartments in his house. We may in the past have treated the coal bin as a mere poor relation or humble servant. We gave it the poorest room in the house. We even hired other people to attend to it so as not to have to soil our fingers by contact with the fuel problem, but nowadays I think one can observe a much more kindly attitude toward this humble factor in our domestic arrangements. We have been forced, as it were, to enter into diplomatic relations with the coal bin and to treat it with consideration and very great respect.

The greatest coal bin in the Dominion of Canada is the coal bin of the railway companies. Many of you gentlemen have seen some of the young mountains of coal which the transportation companies are forced to maintain at their terminal points. There are in Canada over 5,000 locomotives whose appetites require an average ration of from 100 to 160 pounds of coal for every mile run. The engine which drew some of you gentlemen from Montreal to Toronto last night burned not less than sixteen and a half tons of bituminous coal. If we allow that the average tender on the average engine holds ten tons of coal, then the requirements of the railways for a single loading of their tenders amount to over fifty thousand tons. The total coal consumption of the railways of Canada in the last year for which Ottawa gives official figures (1916) was 8,995,123 tons, which cost them $27,961,186. This was almost as much as the total Canadian import of bituminous coal and slack in the same year.

But, of course, what the railways themselves consume is only the beginning of the coal problem for the railway managers. Although we imported only about 9,000,000 tons of bituminous coal and slack in 1916, the railways hauled that year 18,122,835 tons. In addition to this they hauled 7,057,628 tons of anthracite coal and 1,772,854 tons of coke. The hauling of fuel both for themselves and the public amounted to approximately 25,000,000 tons, or over one-fifth of the total freight tonnage carried by all the railways of Canada that year. It was four times the weight of the ore carried and twice the weight of the total products of manufacture which were carried by the railways. It required the service of 29,948 trains of 23 cars per train, or the exclusive service for one year of approximately 1,000 freight engines and 23,000 freight cars.

The weight of bituminous coal carried by the railways runs, as a rule, just a trifle less than the weight of all the grain produced in the Dominion.

I give you these figures to impress upon you the extraordinarily intimate connection between the coal situation and the railways of Canada. I cannot refrain from remarking, just in passing, that although coal carrying represents such a great part of railway work, it does not represent a proportionate part of railway earnings. Coal is carried farther in Canada for less money than in any other country in the world. It costs the coal dealer less for the freight on a ton of coal transported sixty miles than to team that same ton one mile in the city of Montreal or Toronto. The recent rail rate increases give the railway about 15 cents per ton more than before on an average anthracite shipment from the mines to Toronto. One hears a great deal about this increase, yet the general increase of 66⅔ per cent. in teaming costs due to increased price of oats, labor and horseflesh has scarcely been mentioned in the public press.

Now, I intend first of all to outline roughly the machinery of coal distribution in Canada as it existed before the war. It is necessary to divide the country into five districts, according to the fuel situation in each. I will then try to show what each district used, where it obtained its supply and how.

Starting in the east, let us define District No. 1. It reached from Halifax to, say, Montreal. It was supplied with bituminous coal from the Nova Scotia and Cape Breton mines. This coal was distributed partly by rail, but chiefly by boat. In 1913, the last normal year, the Dominion Coal Company distributed 1¾ million tons by boat in the St. Lawrence alone, and the Nova Scotia Steel Company another ½ million. The famous, or infamous, "Storstadt" which sank the "Empress of Ireland," was one of the fleet of vessels distributing this coal. Very little of it, I might say, was consumed farther west than Montreal. Nova Scotia and New Brunswick consumed quantities in addition to the St. Lawrence requirements. Much of this, also, before the war was carried by steamer or by the humbler but more picturesque schooners of this region.

District 2, overlapping District 1 to some extent, reached, one might say, from Quebec City and towns like Sherbrooke, P.Q., and St. Johns, P.Q., west to Windsor and Sarnia and north to Sudbury, North Bay and Cochrane. This was, and is, the great coal importing area of Canada. It is here that the major portion of our anthracite coal was consumed and the chief share of bituminous coal was converted into energy and manufactured goods. It came by three different means— (1) by rail, (2) by water, and (3) by car-ferry. The chief rail points from which coal passed directly into Ontario were Black Rock, Victoria Park, Suspension Bridge, Niagara Falls and Bridgeburg. These are the points we call the Niagara Frontier—where special precautions had to be taken this past winter, as I shall describe later on.

Another direct rail connection from District 2 to the United States is, of course, at the Soo, but no coal of any account passes here.

Of the car ferry connections the largest are at Sarnia-Port Huron and Windsor-Detroit. A considerable amount of Illinois coal passes here. Much more crosses Lake Erie from Cleveland to Port Stanley; Ashtabula to Port Dover; Ashtabula to Port Burwell; and Lake Ontario from Ogdensburg to Prescott and Charlotte to Cobourg. I might say that practically the only traffic from Port Burwell is empty coal cars southbound and loaded coal cars north. This one little port accounts for 54 cars of coal per day in good weather.

So much for the direct rail connections and the car ferries. There is still a traffic in coal schooners and steamers of a sort plying on Lake Ontario from Oswego to Kingston or Toronto, and on Lake Erie from the American coal ports to the Canadian ports I have just named.

These are the coal-carrying connections between District 2 and the American coal fields. The coal thus received is distributed chiefly from Toronto, Hamilton and London to the rest of the older parts of the province.

In District No. 3 let us place all the north shore of Lake Superior west to the eastern boundary of Manitoba. In this region, Port Arthur and Fort William are the

*Paper read before the first general professional meeting of the Canadian Society of Civil Engineers, held at Toronto, March 26-27, 1918.

central points. Another port of which little is heard is Jackfish, a C.P.R. point where this company obtains enough coal by water during the summer to supply the North Shore divisions all year round, without having to burden the line itself by hauling coal via Toronto and Sudbury. That, of course, is a digression from my point. The centres of public distribution are the Twin Cities. Many of the vessels which come north for cargoes of eastbound grain bring coal on the up voyage. This coal is scattered westward by the returning empty grain cars from Fort William to Winnipeg. How far west of Winnipeg this movement goes I cannot say definitely, as it depends upon the production and movement of Western coal. Here the American coal coming up the lakes begins to come in competition with the coal from our Western foothills. The greater the production of Western coal the farther east it comes.

District No. 4 might be said to include Winnipeg and the eastern portion of British Columbia, overlapping District 3 to some extent. In its most westerly extension it is fed almost exclusively from the Alberta coal fields.

Of District No. 5 I need only say a word. This takes in the western slope of British Columbia. The railways here use coal and oil fuel. The supplies of coal were and are from Washington and Nanaimo. The consumption is not large and the problem of distribution is not great.

There, Mr. Chairman and gentlemen, you have the outlines of the fuel situation from a transportation viewpoint as it existed before the war. I will take now only a few moments to explain the changes which war has brought about in each district.

In District 1, the steamers plying from Sydney to St. John, Halifax, Quebec and Montreal, have, so to speak, enlisted. The distribution of coal from these mines falls entirely, therefore, upon the railways. The two million tons distributed by boat in the St. Lawrence are now carried by rail. The schooners on the coasts of Nova Scotia and New Brunswick continue to do their share, but even there the railways have had to assume an extra burden. I might add that this Eastern Canadian bituminous coal is now moving into District 2 as far as Ottawa and Cornwall. The increased consumption of coal in District 1 has made necessary the use of American coal here too, which is hauled north via Montreal and then east.

In Districts 2 and 3 there have been two changes: 1st, a falling off of water-carriage of coal on the lakes, and 2nd, the congestion of the American roads which made it impossible to send the proper number of coal cars south for coal on account of the danger that they would be lost down there even before they could be loaded at the mines. The loss of the water-carriers was perhaps the more serious of these two considerations. From these three districts a tremendous proportion of the water-carriers have disappeared. Practically the entire burden — amounting, as I said, to 2,000,000 tons or 50,000 carloads for St. Lawrence points alone—has been forced upon the railways. They met this condition by (1st) building more coal cars, (2nd) by converting sand and gravel cars for coal use, (3rd) by enforcing economy in their own use of coal, (4th) by pressing box cars into the coal-carrying service, and (5th) by trying to move as much coal as possible in the summer season when the traffic may take advantage of easier transportation conditions. By a campaign among the big shippers asking them to accept coal deliveries last summer instead of in the fall, much good was accomplished. With respect to the danger of losing our coal cars in the United States, thousands of tons of coal were worked through the American tangle in returning Canadian "empty" box cars. The use of box cars for coal carrying can only be applied from mines and docks where there are devices for loading and unloading these cars with coal. Fortunately, these devices are already established in the West, *i.e.*, Districts 3 and 4, otherwise we should have had a lot of trouble sending to Winnipeg special coal cars instead of using the westbound empty box cars.

I must make special reference to the work done on the Niagara frontier this winter by the administrative committee of the Canadian Railway War Board. In this work all roads co-operated to the fullest extent. The incoming coal cars at Black Rock, Bridgeburg, Victoria Park, Niagara Falls and Suspension Bridge were forwarded rapidly to Hamilton, Toronto, London and other points without respect to what road they were routed by. In spite of blizzards and exceptional weather conditions about 5,000 cars (chiefly coal) were put through in a period of two months over and above what would have been regarded as a normal movement. This meant to the Canadian consumers about 150,000 tons of coal extra.

So much for Districts 1, 2 and 3. In District 4, that is, from Winnipeg to the eastern half of British Columbia, the question is now being discussed whether the Western bituminous mines could not look after the bituminous requirements of that district while the lignite, being compressed into briquettes, might replace the anthracite. This is a consummation devoutly to be desired and members of the Canadian Railway War Board have already taken up the question with a view to being ready, as far as transportation is concerned, to make Western Canada, by the winter of 1919-20, as nearly self-sufficient as possible. How far this is possible I cannot even guess, although one might mention some of the factors governing the situation.

First, as to production of both bituminous and lignite coal, the mines have never been able to turn out maximum quantities (*a*) because of labor troubles. High rates of pay enable men to take time off with impunity (*b*) because of lack of storage facilities for lignite coal.

But even with these, much might be done, so far as the railways are concerned, by a concerted effort on the part of the mines, the railways and the public to persuade the consumers to place their orders for delivery during the slack months.

Conditions in District 5 have not changed. There is some talk of having the Californian supply of oil fuel for railway locomotives cut off. This would be very serious for the railways, as the following figures show: Fuel oil consumed in British Columbia, 1917—Canadian Pacific received 48,763,554 gallons and consumed 46,608,660 gallons; Grand Trunk Pacific received 6,350,840 gallons and consumed 6,303,500 gallons; Esquimalt and Nanaimo Railway used 2,646,400 gallons; Pacific Great Eastern Railway used 1,638,000 gallons.

I have described briefly the changed conditions of the Canadian fuel traffic and how the railways have met these changes.

Just one word now about the special means of internal economy which the railways have undertaken with a view to economizing in their own use of coal. I might mention that in Districts 1 and 2 the coal is poorer in quality (and higher in price) than ever before. This is due to the labor scarcity at the American mines where the product is no longer picked over as it used to be.

First, regarding passenger trains, the Canadian Railway War Board, and the individual railways before the Board was formed, have cut off trains whose total yearly mileage would amount to 12,000,000 miles. Assuming

an average of one hundred pounds of coal per passenger train mile, this means 600,000 tons saved.

Parlor and observation cars have been eliminated, except in cases where there are combinations of dining cars or sleepers.

Fewer sleepers are attached to night trains, thus a greater use of upper berths is made and the wheel resistance of extra coaches is done away with.

The speed of all trains has been reduced to the point where a maximum of effort is obtained from a given amount of fuel. No train is allowed to run at excessive speed to make up time. This has always been a practice very hard on coal economy.

Special trains and the hauling of private cars, except at the request of government officials have been done away with.

Even more important economies have been made in connection with the freight services. A campaign for heavier loading resulted in a great improvement. For example, in the movement of freight to St. John during the month of January, 1918, as compared with January, 1917, the average load per car rose from 26.4 tons to 32.3, an increase per car of 5.9 tons. The saving from this improvement on this traffic alone that month was 1,313 cars and over 7,300 tons of coal. There was also a saving of the time of eleven locomotives and fifty-five engine and train men for that month, besides a great many shopmen, yardmen, car checkers, repairmen, etc.

The handling of less than carload lots of freight has been so rearranged as to load the cars more heavily.

We are thus able to reduce the ratio between net weight and tare weight in any given train. The wheel resistance is lowered. The train is made shorter and can therefore be handled more promptly.

In the actual firing of the engines, further economies have been effected in spite of the lower grade of coal available in Districts 2 and 3. Expert firemen are sent out to show the less experienced men the best way of dressing the fires.

I might say that the old practice of burning worn-out ties on the sides of the railways has been discontinued since the war. In some districts it does not pay to haul these ties to places where the railway can use them. In these cases the farmers alongside the track or the railway trackmen are being given the ties for firewood. The greater proportion of them, however, are taken to the shops and roundhouses. It was found impossible to saw these ties owing to the amount of gravel and grit with which they were impregnated. A device has been made which breaks the ties into appropriate lengths and they are now used under the boilers.

I do not think, Mr. Chairman, that there is anything that I can add to what I have already said. As a railway man, I may as well tell you frankly that I take great pride, along with my fellow railroad men, in the record which the Canadian railways have established, not merely in the handling of fuel, but in the handling of food, munitions and domestic traffic. We have had two exceptionally severe winters. We have had labor shortage. Fuel has been scarce and of low quality. The nature of traffic and the direction of traffic has shifted and changed overnight in a manner sufficient to strain the resourcefulness of even the most alert railroad men in the world. Changes which I have indicated with regard to the movement of coal in Canada apply even with greater force to the movement of other commodities. The Canadian railways have moved hundreds of thousands of soldiers, eastbound and westbound; they have handled 75,000 foreign laborers passing from Vancouver across the continent enroute to France. There have been some difficulties, but on the whole I think there have been fewer railway troubles in Canada since the war than in any other country in the world. It is perhaps unfair of me to take advantage of your good nature to add this word of praise for the railroaders, but I should be a very poor spirited and unenthusiastic railroader myself if I failed to mention it.

I thank you for your very kind and attentive hearing.

NOVA SCOTIA STEEL AND COAL COMPANY

The annual statement of the Nova Scotia Steel and Coal Company is issued this year to cover the operations of the parent company and all its subsidiaries, thus a consolidated balance statement is issued to cover both the Nova Scotia Steel and Coal Company and the Eastern Car Company. On this account, comparisons with previous years cannot be made satisfactorily. The change has evidently been made at the suggestion of the auditors of the company, as the Scotia Company has guaranteed the bonds of the subsidiary and owns all the common stock. An analysis of the general consolidated balance sheet indicates that Scotia is now in a strong financial position, the total current assets being over $10,000,000 in excess of current liabilities. The combined profits from operations, after providing for maintenance and renewal expenditures, but before deducting depreciation, interest charges, etc., for the year ended December last was $3,069,449.23, before deducting proportion of commissions and discounts on securities written off, provision for depreciation, income tax, etc., which amounted to $976,113.20, leaving profits of $2,093,336.03. Deductions included interest on the 5 per cent. mortgage bonds of the Nova Scotia Steel and Coal Company, Limited, $287,121.13; on the 6 per cent. debenture stock of the Nova Scotia Steel and Coal Company, Limited, $263,296.87; on the 6 per cent. mortgage bonds of the Eastern Car Company, Limited, $58,401; on bank loans and advances, $144,040.20; total, $752,858.20, leaving total net profits of $1,340,477.83, which, added to the surplus on January, 1917, of $3,532,114.63, made an amount for distribution of $4,872,592.46. Other deductions included dividends on the 8 per cent. cumulative preference stock of the Nova Scotia Steel and Coal Company, Limited, $80,000; cash dividend declared on the ordinary stock of the Nova Scotia Steel and Coal Company, Limited, $562,500; stock dividends declared on the ordinary stock of the Nova Scotia Steel and Coal Company, Limited, $2,500,000, totalling $3,142,500, leaving the surplus carried forward $1,730,092.46.

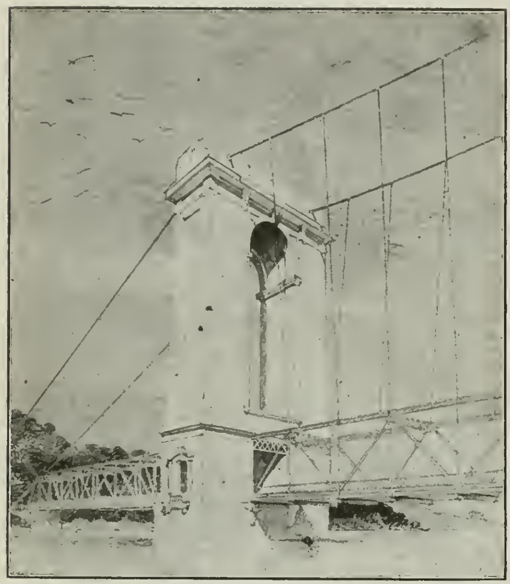
The company is in a strong financial position and has a splendid future. The work of Mr. Frank H. Crockard, the general manager, has proved very effective, but its full value will be demonstrated after the war, when financial and general conditions are again normal. Mr. Crockard's ability and experience are assets of considerable importance to the company. Mr. Thomas Cantley remains as chairman of the board and his counsels have been of great use during the past year. The company has an influential directorate, Mr. W. D. Ross looking after the financial affairs of the corporation.

Rope strain is a factor that often occasions considerable controversy regarding the actual tension upon the rope when loaded. This subject has frequently been the basis of lengthy discussions, but the difference of opinion invariably arises from the lack of sufficient knowledge respecting the fundamental principles of forces in action. To fully understand the question of rope strain it is necessary to familiarize one's self with the third law of motion—namely, "action and reaction are equal and opposite"; that is, when a force is applied, a corresponding force is exerted in the opposite direction. One of the apparently debatable points in connection with the strain upon a rope, is the different ways in which this reaction takes place. If a rope is secure at one end to a hook in the wall and a man pulls on the other end with a force of 100 lbs., it is obvious that the rope is under a tension of 100 lbs. However, if the rope is removed from the hook and a man is placed to oppose the pull of the other, some persons are under the impression that the rope is under a strain of 200 lbs., due to the pull of 100 lbs. at each end of the rope.

SUSPENSION BRIDGE FOR GRAND'MERE, P.Q.

By Romeo Morrissette
Three Rivers, Quebec

GRAND'MERE is fast becoming the centre towards which are converging several growing municipalities, including Lac a la Tortue, Turcotteville and Grandes Piles. Before entering Grand'Mere, it is necessary to cross the River St. Maurice, a few hundred feet above the power plant of the Laurentide Power Co. Heretofore access has been secured by means of a ferry, consisting of a large scow moved by hand, but latterly by gasoline launch.



Proposed Suspension Bridge at Grand'Mere

This means of transportation being slow, the construction of a bridge has become a necessity. The Laurentide Co., Limited, which has a large paper plant there, and also other interests on the eastern shore, have decided to erect the suspension bridge illustrated herewith.

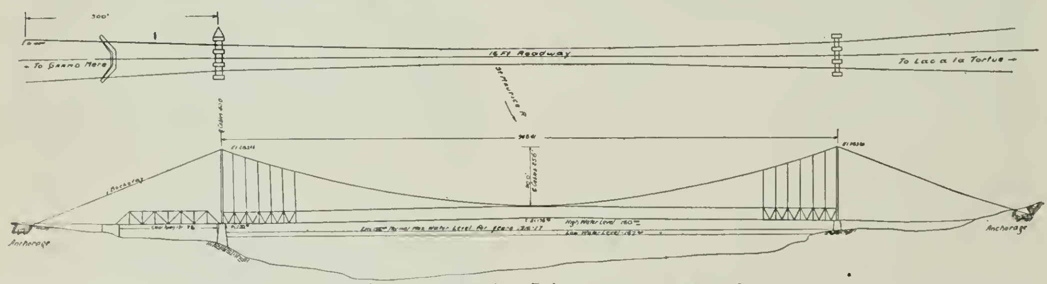
The concrete abutments are completed; they are 28 feet wide, 20 feet deep with two wings of 33 feet each. The piers are also finished to elevation 160. Each will carry a concrete pylon, as shown on the accompanying sketch. The top of the pylon will reach elevation 285.33, giving a height of 115.33 feet above the bridge floor.

The 151-foot 9¾-inch span, situated on the side of the town of Grand'Mere, and extending from the bank to the western pier, is in place, and is used temporarily as an approach to the ferry which runs between the piers and the eastern abutment. The span is designed with a 16-foot roadway and the truss is 20 feet high.

At present the work is temporarily suspended due to war conditions, but it is the intention of the company to resume construction just as soon as conditions warrant it.

Last year, they applied and got from the Federal Government, permission to erect the bridge. The details of the central truss are not completely defined yet, but a general idea of the project follows: The central span will be 948.41 feet long with a roadway of 16 feet. It will be of the Howe type, bearing on steel cross-ties, fastened to vertical wire, probably 6 inches in diameter; floor beams will run longitudinally and will be covered with two laying of planks. The truss will be approximately 18 feet high and will be suspended from a series of vertical steel wires attached to a cable on both sides of the bridge, the diameter of this cable will be 8 inches. The deflection of the cable is estimated at 25 feet 6 inches and the difference in floor elevation between the piers and the centre of the span 6 feet. This has been estimated in order to meet with any future developments due to live load.

Two concrete anchorage piers will be built and will be solidly fixed to the rock by iron bars. Eight-inch steel wire will run on each side of the bridge from these points to the top of the pylons as backstays.



Plan and Elevation of Suspension Bridge at Grand'Mere, Que.

According to the French "Gasworks Journal," sawdust and wood are to be used in Switzerland and France as substitutes for coal. In Geneva 10 per cent. of sawdust is added to the coal in vertical retorts; as an alternative, logs of wood, 3-ft. in length, are placed in the retorts, which then contain only charges of 260 lbs., instead of 1,240 lbs. of coal. Wood and coal are worked alternately on two benches, and the gases not being kept separate, the resulting tars are not acid. At La Chaux de Fonds, in the Jura, 375 lbs. of sawdust are mixed with 66 lbs. of coal in horizontal retorts, which take 990 lbs. of coal. In Neuchatel the coal is mined with 28 per cent. of coal.

According to official information, the County of Northumberland and Durham has come into the good roads system of the province. This means that an additional 375 miles of roads comes into the good-roads system.

The total length of the Australian Transcontinental Railway is 3,489 miles, of which 729½ miles are of 3-ft. 6-in. gauge, 1,946 miles of 4-ft. 8½-in. gauge, and 813½ miles of 5-ft. 3-in. gauge. Western Australia, owing to financial difficulties, has not yet been able to change the 3-ft. 6-in. gauge from Freemantle to Kalgoorlie to standard gauge, and there are two more breaks of gauge in South Australia before Adelaide is reached.

THE GREATER WINNIPEG WATER DISTRICT

(Continued from page 290)

"We recommend taking the water out of Shoal Lake by gravity rather than pumping it over the summit in pipe lines.

"We estimate that the total cost to the Greater Winnipeg Water District of building the intake, Falcon River diversion works, concrete aqueduct and steel and cast-iron pipe lines, including crossings of streams and rivers, waste weirs, and other appurtenant works, will be $13,045,600."

This estimate does not include the cost of acquiring land, or of branch pipes to the different communities; neither does it include any allowance for water damages, nor for interest charges.

"We recommend as a part of the plan, but not for immediate construction, that a new storage reservoir, holding about 250,000,000 gallons, and estimated to cost between $300,000 and $400,000, be built at a point about a mile east of Transcona, and that a main pumping station be there established to force the water to the city through the 5-foot pipe, and through branches to be laid to the different sections of the city and district requiring the water. This reservoir and pumping station should be completed and ready for use before the demands for water shall have reached the capacity of the pipe line."

In order to establish the route line it was necessary to run 362 miles of transit lines, 1,317 miles of levels, 95 miles of precise levels, 360 square miles of topography.

In addition to the above, 12,000 feet of borings were made and recorded.

The difference in elevation between Indian Bay and the McPhillips Street reservoir in Winnipeg is 293 feet and the length of the line is 97 miles approximately, so that the average drop in the slope is slightly greater than ½ foot in 1,000 feet. The aqueduct as finally designed is a horseshoe-shaped concrete conduit to be built in place in two sections, invert and arch; the sizes of section and slopes on which each is constructed are given below:—

Slope of aqueduct.	Dimensions of sections.
0.11 inches per 100 feet	10′ 9″ x 9′ 0″
0.279 inches per 100 feet	10′ 9″ x 9′ 0″
0.300 inches per 100 feet	8′ 9″ x 7′ 4⅝″
0.382 inches per 100 feet	8′ 3¾″ x 7′ 0″
0.480 inches per 100 feet	7′ 11½″ x 6′ 8½″
0.600 inches per 100 feet	7′ 7½″ x 6′ 5¼″
0.684 inches per 100 feet	7′ 5½″ x 6′ 3½″
0.744 inches per 100 feet	7′ 4″ x 6′ 2¼″
1.290 inches per 100 feet	6′ 7″ x 5′ 6⅛″
1.537 inches per 100 feet	6′ 4¾″ x 5′ 4¾″

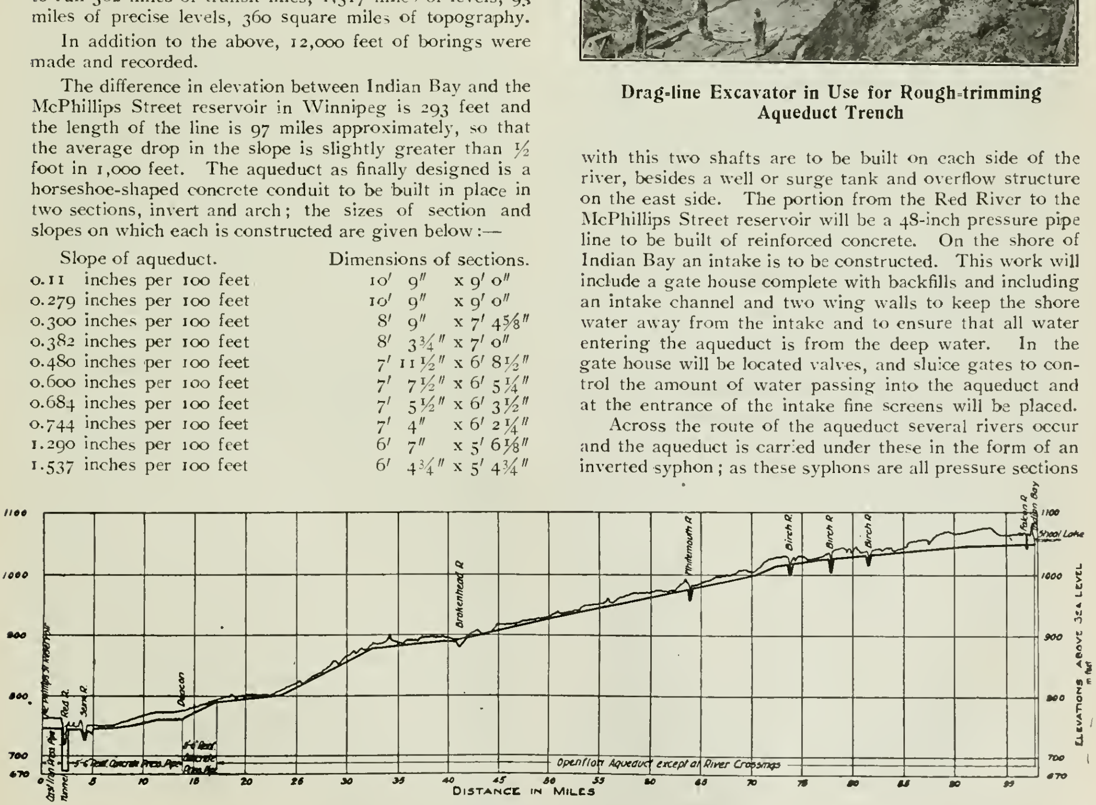
The dimensions, as stated above, are for one—the major—section of the work only, namely, that portion from the intake on the shores of Indian Bay to a point four miles east of the proposed reservoir site at Deacon. This section is approximately 81 miles in length and is constructed as a cut and cover "flow line" aqueduct. A cut and cover "flow line" aqueduct is one which is so built, in a comparatively shallow trench requiring embankment to provide the necessary covering, as to follow the slope of the country. It therefore does not run full nor under pressure, but the water flows with a free surface as it would in a ditch or channel or other similar structures. From a point four miles east of Deacon to McPhillips Street reservoir in Winnipeg the structure will be a circular pipe operating under pressure across the Red River Valley. This pipe will be constructed of reinforced concrete 8 feet in diameter and from Deacon to the Red River is 5 feet 6 inches in diameter.

At the Red River crossing will be a cast-iron lined tunnel under the river 5 feet in diameter and in connection

Drag-line Excavator in Use for Rough-trimming Aqueduct Trench

with this two shafts are to be built on each side of the river, besides a well or surge tank and overflow structure on the east side. The portion from the Red River to the McPhillips Street reservoir will be a 48-inch pressure pipe line to be built of reinforced concrete. On the shore of Indian Bay an intake is to be constructed. This work will include a gate house complete with backfills and including an intake channel and two wing walls to keep the shore water away from the intake and to ensure that all water entering the aqueduct is from the deep water. In the gate house will be located valves, and sluice gates to control the amount of water passing into the aqueduct and at the entrance of the intake fine screens will be placed.

Across the route of the aqueduct several rivers occur and the aqueduct is carried under these in the form of an inverted syphon; as these syphons are all pressure sections



PROFILE

they are circular in shape and are built of reinforced concrete.

The policy of the District has been to let contracts progressively. As the organization proceeded, tenders were invited and contracts for separate portions awarded. The total number of contracts let thus far is 69 and the amounts involved in these range from a few hundreds of dollars in some cases to considerably over a million dollars in others. Owing to the magnitude of the undertaking it would be impossible to make other than an approximate estimate of the quantities of construction involved, consequently each tenderer is asked to put in separate bids for the different items included in the contract and therefore should the actual quantities differ from those estimated the District has a fixed basis for settlement, paying only for work actually done.

Work to be performed, but not covered specifically by contract, is done under extra work orders. In each case these must be recommended by the chief engineer and approved by the board of commissioners and by the board of administration. The District places an inspector on each job and an accurate record of the cost of labor and materials is obtained. Payment for work done under "extra work" orders is made on a basis of 5 per cent. profit to the contractor on material, and 15 per cent. on labor, to care for his overhead and plant charge and his profit.

Owing to the inaccessible nature of the greater portion of the country through which the aqueduct was to be built the decision was early made to construct a standard-gauge railroad parallel to the line of the aqueduct in order that the immense amount of material necessary for the construction could be quickly and efficiently transferred to any point on the works. When it is known that the comparatively small amount of supplies necessary to maintain the location survey parties in the field had to be packed in on men's backs or taken by canoe up the rivers from the railway lines in the north to different parts of the location lines, it will be possible to appreciate how difficult it would have been to handle the construction materials for the aqueduct in any other manner than that upon which the board decided.

In order that the administrative and engineering staffs might be in close touch with the work, the District constructed a telephone system by which the staff at Winnipeg is in connection with all divisional points and with its pits on the work. This system was constructed by District forces and in all about 95 miles of line was put up, using No. 14 B. & S. copper wire. The work was commenced on May 5th, 1914, and completed October 22nd, 1914. The total cost of the system to June 30th, 1916, was $32,505.23, which includes extensions from the time of installation. The District employs a troubleman, whose headquarters are located approximately midway along the line, and although considerable trouble is experienced from falling trees and storms, owing to the thorough patrolling of the line it is rarely out of order except for short intervals of time.

The Falcon River emptied into Shoal Lake through Indian Bay. This river drains a large area of swamp and muskeg country to the west of Indian Bay, and its waters are highly colored and possess a strong vegetable taste and odor. In order to give the water in the bay the opportunity to clarify and bleach itself by natural agents, such as sun and wind and wave action, it was necessary to prevent the water of the Falcon River from mingling with that of Indian Bay, and consequently a dyke was constructed across the southwest angle of the bay and a channel dug through a peninsula of land between Indian Bay and Snowshoe Bay, and in this way the river water is shut off from the bay, flows through the channel and empties into Snowshoe Bay.

From observation made on both sides of the dyke it has been established that the color factor of the water on the aqueduct intake side is only one-ninth of that of the water upon the side on which the Falcon River empties. Comparison of water from the intake with water now supplied the citizens from city wells, show that the new supply of soft water will not differ in color from that to which all are accustomed.

The dyke was constructed during the year 1914 by Messrs. Tomlinson and Fleming, of Toronto, for $87,327. It is 7,000 feet long and contains 230,000 yards of material.

The material of which the dyke is built was obtained from a sand and gravel pit opened up nearby. From a rock outcropping on the shore of the bay near the intake site, the dyke was rip-rapped to protect it against wave action. The top is dressed with clay and sown with grass seed.

The total length of the conduit from the intake at Indian Bay to the McPhillips Street reservoir in Winnipeg is 96.5 miles and is made up as follows: Cut-and-cover concrete aqueduct with capacity of 85,000,000 Imperial gallons per day, 77.5 miles; river syphons and pressure sections of concrete aqueduct of same capacity, 7.1 miles; reinforced concrete pressure pipe (lock joint type) with capacity of 50,000,000 Imperial gallons daily, 9.4 miles; Red River tunnel, cast-iron lined, 0.2 miles; 48-inch pipe line from Red River to McPhillips Street reservoir, 2.3 miles.

Contracts for the construction of 85.2 miles of the aqueduct were let in October, 1914, and work was started on this in the spring of 1915. As stated above, 77.5 miles of this is of the "flow line," "cut-and-cover" type. The river crossings which are constructed as inverted syphons and certain other portions which are below the hydraulic gradient and will therefore flow full of water under pressure, are built of reinforced concrete and are circular in section. The "cut-and-cover" section is in the form of a horseshoe-shaped arch resting upon an invert whose upper surface is curved and concave to the earth's surface.

Work on the 85.2 miles of aqueduct was let under contracts 30 to 34, inclusive, as follows: J. H. Tremblay Co., Limited, contract 30, 20.15 miles, $945,945; Thos. Kelly & Sons, contract 31, 17.15 miles, $1,301,485; Northern Construction Co. and Carter, Halls, Aldinger Co., known as the Winnipeg Aqueduct Construction Co., contract 32, 18.2 miles, $1,268,650; contract 33, 16.1 miles, $1,137,070; contract 34, 13.0 miles, $1,489,520.

The method of trench excavation on the several contracts differ considerably in detail and accomplishment.

On contract 30, excavation is done by means of what is called a walking dredge. The dredge is supported on four pads, each about 4 feet wide and 6 feet long and constructed of heavy timber. These pads or feet are set at the corners and two intermediate pads are operated with chains and winches in such a manner as to shift the weight of the machine onto the intermediate pads and at the same time move the machine forward. The weight is then transferred to the corner pads and the intermediates move forward. The machine straddles the excavation and removes the earth with a scoop-shaped bucket which is hinged at the end of a boom. This machine is capable of digging about 1,000 cubic yards of material daily, or enough to make 500 two-horse wagon loads. One dredge was brought across country to the District's work, "walking" the total distance of 60 miles over marsh and slough and hard ground alike. Four such machines have been engaged on this contract.

On contract 31, part of the trench to be cut is deep and consequently wide. The excavation at these points is being done with drag lines. Thew shovels have been used in the shallow cuts. Where boulders are encountered these are blasted in place and the broken pieces are removed by the shovel. When the cubical dimensions of the boulders exceed one-third of a yard the removal is paid for as rock excavation, otherwise the work is classed as earth excavation. Part of the work on this contract is through soft and boggy country and the contractors are using a drag-line excavator which type machine is particularly adaptable for work in swampy country.

On contracts 32, 33 and 34, drag-line excavators are being used for trench excavation and for backfilling of earth over the finished aqueduct. These machines are equipped with a trestled boom which is lowered or raised by a special engine located in the housing as are the engines controlling the bucket and swinging gearing. The upper structure of these excavators, including the bucket, boom, engine and housing, and the boiler, may be swung around the full circle on rollers set upon a frame. This frame is carried on wooden rollers set upon rectangular pads made of heavy timber. The pads rest upon the ground and the area of these depend upon the weight of the machine to be carried and the nature of the ground. When a move is necessary the pad nearest the excavation is picked up and swung around to the rear, the bucket is then anchored and the machine pulled backwards over the rollers. The rollers are then blocked and the digging proceeds. The machine stands at the end of the open ditch and pulls the bucket and excavated material towards itself. The bucket is then elevated and the whole machine swings and the material deposited as desired. This type of machine excavator will work in ground which will barely support the weight of a man. There are several sizes on the work, the smallest being equipped with a 1¾-yard bucket and the largest, weighing 150 tons, equipped with a 3½-yard bucket. The large machine will excavate 5,000 yards of material in 20 hours. To give a popular illustration of the amount of earth handled by this large drag-line, if the supposition is made that teams, hauling dump wagons of 2 yards capacity, require 1 hour to make the round trip, then it would take 125 teams to haul away the material excavated by this machine.

The machine excavation is not carried closer than 6 inches to the final grade. The removal of the remaining 6 inches, which is done by hand, and is called "hand trimming," is done just in advance of the setting of the profile forms between which the concrete invert pads are to be poured. This ensures firm and dry bottom upon which to place the concrete. The trench bottom is trimmed out to a neat grade and to a concave cross-section.

As is the case with the excavation methods, the details of the mixing of concrete are worked out differently on the several contracts, each plant being designed as the most expedient for the part of the country in which it is being used. On contracts 30 and 31, where the ground for the most part is solid, the plants are similar in arrangement. The mixer is set upon frame work which moves along on a wide-gauge track laid on the railway side of the aqueduct and close to the trench. The concrete aggregate is unloaded from side-dump cars on to temporary platforms. These platforms are moved from time to time as the work progresses, so that the concrete materials are always opposite the point at which concreting is in progress. The aggregate is delivered to the mixer in large-sized wheelbarrows on contracts 30 and 31. The barrows are previously measured and thus it is possible to get the exact amount of aggregate to place in each in order to have the correct amount for every batch. One man stands at the mixer, whose duty it is to add the cement.

The average time of mixing of each batch is 2 minutes, depending, however, upon the speed at which the mixer revolves. The time of mixing is under the control of the inspector on the work, who may require the continuation of the mixing until he is satisfied that the batch is thoroughly mixed and that there is no segregation of material. Continuous or gravity mixers are not allowed and each batch must be mixed separately. No concrete is allowed to drop free in air more than one foot and any chute or other means of conveying the concrete direct from the mixer or from a container into the work must not set at an angle which would cause segregation of the material in the mixed concrete.

Part of the material from the excavation is placed on the railway side of the trench, forming a levelled dump, and upon this a narrow gauge track is laid. A track upon an elevated trestle leads both ways from the mixer and is connected by switches to the track laid along the trench. The concrete is carried in small dump cars drawn by gasoline dinky engines to the work and is poured into the forms through spouts or chutes. As a rule, concrete is not hauled farther than one-half mile on either side of the mixer and when the work has progressed so that the distance for hauling exceeds one-half mile, the mixer is moved and the plant is re-established farther along the work.

(Concluded in the next issue.)

SECOND ANNUAL MEETING OF THE JOINT COMMITTEE OF TECHNICAL ORGANIZATIONS

At the second annual meeting of the Joint Committee of Technical Organizations, held last week in the Mining Building of the University of Toronto, Col. Carnegie, of the Imperial Munitions Board, and W. E. Segsworth, administrator of vocational training in the Dominion of Canada, expressed the opinion that the vital need of the day was technical training, both for the workingman and the soldier.

H. H. Couzens, of the Toronto Hydro-Electric Commission, was appointed chairman for the ensuing year, and Wills Maclachlan was re-elected secretary. The following representatives of organizations were elected to the joint committee: Canadian Mining Institute, W. E. Segsworth; Canadian Society of Civil Engineers, Prof. L. M. Arkley; Association of Ontario Land Surveyors, Russell R. Grant; Society of Chemical Industry, E. P. Mathewson; Engineering Alumni Association, University of Toronto, H. G. Acres; Engineering Alumni Association, Queen's University, Alex. C. Longwell; Engineers' Club, W. A. Bucke; Royal Canadian Institute, Harry Jewell; Canadian Manufacturers' Association, G. M. Murray; Canadian Engineers, Military District No. 2, Major L. L. Anthes; American Society of Mechanical Engineers, C. B. Hamilton; American Institute of Electrical Engineers, W. G. Gordon; Institution of Electrical Engineers (England), S. L. B. Lines; Ontario Association of Architects, R. K. Sheard.

TORONTO SECTION, AM. INST. OF E.E.

At the annual meeting of the Toronto Section of the American Institute of Electrical Engineers on Friday, April 19th, in the lecture room at 96 King Street West, at 8 p.m., Paul Ackerman, engineer, Toronto Power Co., will present a paper on "High Tension Insulators from the Operating Viewpoint."

Election of officers will take place at this meeting.

Canadian Society of Civil Engineers Discusses Fuel Problem

First General Professional Meeting of the Canadian Society of Civil Engineers a Pronounced Success.—Fuel and Power Situation Exhaustively Discussed

THE first serious attempt to thoroughly investigate the fuel situation in the Dominion took place at the Physics Building of the University of Toronto at the initial general professional meeting of the Canadian Society of Civil Engineers on March 26th and 27th.

About one hundred members of the society were in attendance at the opening meeting on Tuesday afternoon when the fuels, their transportation and development were considered.

B. F. Haanel, chief of the fuel division of the Department of Mines, Ottawa, opened the meeting with a paper on the fuels of Canada. The situation obtaining in Canada to-day, he attributed to conditions in the United States, the ease with which fuels are imported from that country, and the apathy displayed towards the exploitation of certain of our own fuel resources. While not wholly dependent on the United States for her fuel supply, Canada imports from her neighbor 55 per cent. of her total coal requirements and 91 per cent. of the crude and refined oil products used. In analyzing the fuel resources, their location and extent, he stated that in addition to the coal reserves, there are 37,000 square miles covered with peat bogs, 12,000 square miles of which lie in the central provinces. He dealt with the preparation of lignite and peat for economic use and expressed the opinion that only a small amount of money would be necessary, compared with the immense value which the solution of this vexed question would be to the country. In this connection, he stated that there were seven bogs convenient to Toronto which could supply the city with 26,500,000 tons of fuel.

Transportation from the fuel viewpoint was dealt with by W. M. Neal, general secretary of the Canadian Railway Association for National Defence, Montreal. Referring to the bituminous and lignite mines of the West, he said that they had never been able to turn out a maximum on account of labor conditions. A tribute to the records the railways have made was paid by Mr. Neal, who stated that one-fifth of the total tonnage carried by them is coal.

Sir William Hearst extended a hearty welcome to the engineers and assured the meeting that the government was ready to assist and anxious to co-operate with them.

In speaking on the rational development of Canada's coal resources, W. J. Dick, mining engineer of the Commission of Conservation, Ottawa, said that the future of Canada was not in the hands of her statesmen but in those of her miners. He argued that the scarcity of coal would force many European industries to Canada after the war and suggested the formation of trade boards to regulate mining and to prevent wasteful methods. He expressed the opinion that the final solution of the scarcity of anthracite would be the manufacture of artificial anthracite by municipal gas plants. "It is not beyond the bounds of reason to foresee a condition whereby a householder in the place of his ton of anthracite will receive a ton of smokeless coal, without slate, a month's supply of cooking gas, 40 miles of motor fuel, enough fertilizer to start a small garden, and tar sufficient to allay the dust in front of his house,—all for less money than he now pays for inferior coal." He claimed that any reform in the cost of fuel in central Canada should see a reduction in the cost of domestic heating and a mitigation of the smoke nuisance.

"The Utilization of Peat," was taken up by John Blizard, technical engineer of the division of fuels and fuel-testing of the Mines Branch, Department of Mines, Ottawa, who predicted a speedy inauguration of the peat fuel industry in Canada, and a paper on "The Low Temperature Carbonization of Fuels" was read by E. Stanfield, of the same department.

In reviewing the papers, the chairman, H. H. Vaughan, president of the society, referred to the importance of not only discussing the fuel situation in Canada and the use of the present fuels as well as others which were advocated, but also of promoting economy in the use of them. By the use of certain devices it was possible to save thousands of tons of fuel and so to help minimize the difficulties. Mr. Vaughan referred to the fact that the Canadian Pacific Railway was the first railway company in North America to adopt superheaters on locomotives and thus to effect a considerable fuel economy. The papers read, he held, were of great value because the authors had presented information on definite work already accomplished or on certain practicable lines of research.

L. M. Arkley, assistant professor of mechanical engineering, University of Toronto, led the debate on the fuels of Canada. He contended that it was possible to save one million tons of coal annually in Canada by adopting reasonable measures, such as the installation in steam plants of necessary and inexpensive equipment for regulating the volume of air admitted into the furnace and sampling the waste gases as they pass out the flue to determine the proper adjustment.

James Milne, mechanical and electrical engineer of the Department of Public Works, city of Toronto, leader of the discussion on the utilization of peat, stated that he carried out investigations in 1902 in connection with the development of peat as fuel and had arrived at the conclusion that it could be prepared for about $2.75 per ton and that five tons of peat were about equivalent in heat value to three tons of coal.

James White, of the Commission of Conservation, said that the regulation compelling the railway companies to provide spark arresters on locomotives employed in the prairie provinces had done much to reduce the fire risks there. Owing to the fact that lignite coal disintegrated on exposure to the atmosphere, the mining of it was carried on in the autumn and winter and the fuel had to be delivered to the consumers at once. For this reason, he considered that Mr. Magrath's suggestion that lignite might be stored under ground or, if necessary, submerged in water, was most practical. He pointed out that the Canadian Pacific Railway was using oil as fuel because it was found to be cheaper than coal and it removed the risks due to strikes.

Mr. Dowling referred to the use of natural gas in the West. Calgary, he said, was consuming about thirty million cubic feet per day. The possibility of extracting gasoline out of natural gas opened a tempting opportunity for serious waste which should be prevented. The most important item in connection with peat from the viewpoint of George W. Allen, secretary-treasurer of the Canadian Gas Association, was that peat could be used for producing gas and many useful by-products.

To summarize the day's work, suggestions as to the development of Canada's coal resources were: (1) Substitution of coke for anthracite; (2) the introduction of by-product coke ovens, and the transformation of gas plants to include more thorough by-product recovery; (3) carbonization and briquetting of low-grade fuels; (4) the use of pulverized coal as a locomotive fuel; (5) the elimination of waste in mining; (6) greater use of eastern coals to replace imported coal in the area west of Port Arthur, which includes avoiding the use of fuel requiring a long haul wherever it is possible to procure a suitable substitute requiring only a short haul; (7) by the earliest exploitation of our own resources to aim at limiting the necessity for importing fuel from other countries.

The evening session was occupied by a most interesting illustrated address on "The Erection of the Quebec Bridge," by George F. Porter, engineer of construction for the St. Lawrence Bridge Co., Montreal.

On the second day of the session, the efforts made to relieve the fuel situation in Ontario, wood as an emergency fuel, gas for light, heat and power, oil fuel, hydro-electric energy and water powers with relation to the situation were treated.

Albert Grigg, deputy minister of lands and forests, Ontario, outlined the steps taken by the government to place a large supply of wood at the disposal of the municipalities of the province. E. J. Zavitz, provincial forester for Ontario, dealt with the subject of wood as an emergency fuel and Arthur Hewitt, general manager of the Consumers' Gas Co., Toronto, discussed the value of gas for lighting, heating and power purposes.

The possibilities of central heating for the future was the foundation for a most interesting paper by F. G. Clark, chief engineer of the Toronto Electric Light Co. Within ten years, he prophesies, the heating system in large cities will be revolutionized and transportation congestion very considerably relieved by the general use of central heating and of gas and briquettes made from powdered coal piped from the mines to the manufacturing centres as fuel.

Oil fuel and its possibilities was discussed by R. W. Caldwell, chief mechanical engineer of the Imperial Oil Company.

In his address upon "Canada's Water Powers and Their Relation to the Fuel Situation," J. B. Challies, superintendent of the Dominion Water Power Branch of the Department of the Interior, Ottawa, stated that only 10 per cent. of Ontario's available hydro-electric power had been developed. "It is axiomatic," said Mr. Challies, "that our heat, light and power needs must be considered as one great national problem, and also that Canada's domestic and industrial development depends primarily on the co-ordinated use of all the fuel-power resources of the Dominion. Water power," he added, "must take a very prominent part, if the best use of the varied fuel-power resources of Canada is to be achieved."

In his paper on "Railway Electrification," John Murphy, chief electrical engineer of the Department of Railways and Canals, Ottawa, declared that the electrification of railways, especially terminals, with adjacent engine divisions, would save an enormous consumption of bituminous coal and relieve the transportation system. Something like 9,000,000 tons of coal were consumed by our railroads in 1917. It would be possible to save two-thirds, at least, of this coal by the use of electric locomotives. The present per capita hydro power development in Canada is larger than all other countries except Norway. The speaker gave a number of concrete instances to show how electrification of railways in mountain sections, where railroading is most strenuous, had increased their efficiency.

J. M. Robertson, Montreal, director of the Southern Canada Power Company, spoke of the possibilities of relieving the fuel consumption by industries by using more electricity. The consensus of opinion, he said, was that hydro power would be the force which in after years would bring industries to this country from Europe and even from the United States.

The closing address of the day was that by P. H. Mitchell, consulting engineer, of Toronto, on "The Possibilities of Lessening Fuel Consumption in Canada by the Adoption of Electrical Heating." The speaker did not believe this method of heating practicable at present because of its expensiveness, but considered it one of the possibilities of the future.

W. A. McLean, commenting on the papers on the use of wood as fuel, strongly advocated that the timber areas should be systematically reforested so that the future supply might be assured. Speaking on the same subject, James White also supported the regulation of timber-cutting, so that the supply might be conserved. At the present time, he believed, the problem of how to increase production on the land and yet secure a supply of wood by next winter without robbing the farms was extremely important.

W. P. Brereton, city engineer of Winnipeg, stated that the problem of that city was how best to utilize slack obtained by screening at the mines. He considered that the questions of the installation of gas producers and the use of powdered fuel should be carefully studied.

B. F. Haanel stated that certain lignites of the West were suitable for use in their raw state, but others broke up on exposure. The principal trouble was in the furnaces, where the lignite decrepitated under heat and choked the bars. Lignite, however, was eminently suitable for gas producers, especially if the by-products were recovered. The gas was, unfortunately, low in heat value and the cost of distribution was high because much greater volume was required to provide the same heat as, say, coal gas. Central heating will be a factor in the saving of coal and large central plants for producing gas such as the Mond gas plant in Staffordshire, England, would be an advantage if a market for the gas could be found. He also pointed out that when fuel contains a high per cent. of nitrogen, it will pay to recover the same.

W. F. Mickle, Toronto, stated that natural gas had been supplied in Ontario in quantities which, when converted into their equivalent heat values, would be equal to 800,000 tons of coal per year.

Prof. R. W. Angus referred to the fact that neither the producer gas plants nor the Diesel engine had ever had a strong footing in Canada as yet. The fuel question resolved itself into one of educating the public and, he believed, if the Toronto Branch of the Canadian Society of Civil Engineers would co-operate with the other technical societies, it would be possible to show the public how to use fuel economically. Waste should be reduced and thus transportation difficulties minimized.

E. Stansfield, Ottawa, called attention to the absence of information on the surface combustion method of using gas and the effect of preheating of gas on its value for different purposes.

P. H. Mitchell stated that, from his experience with a housing company in Toronto with which he was connected, central heating would be a success economically if meters were installed to insure payment for the quantity of heat used.

H. G. Acres, Toronto, in discussing the heating of houses by electricity, mentioned that if Toronto, with its 80,000 houses, depended upon hydro-electricity for heat, about 1,750,000 horse-power would be required on the coldest days. This was evidently an impossible scheme inasmuch as this quantity of electricity could not be applied to other uses when less heating was necessary. Moreover, the available water power in Canada was insufficient to heat the houses in the country, apart from the demands for power. It was, of course, possible to use electricity to supplement other heating apparatus during the very cold periods. Mr. Acres did not consider that the aesthetical preservation of the Niagara Falls should be considered to the detriment of the development of power. He thought that the water power at Niagara was an instrument placed by Divine Providence to enable us to raise the scale of living and to promote the welfare of the people.

Dr. T. K. Thomson, of New York, advocated the fuller development of the Niagara River water power, and stated that it was quite feasible to throw a dam across to impound water to a depth of 100 feet at a cost of $100,000,000 to develop about 2,000,000 horse power. He said that capital was available for this purpose whenever the authorities would consent to the scheme. The demand for electrical power was increasing at an enormous rate. For example, New York State now had about 3,000,000 horse-power and the annual increase was about 300,000 horse-power.

Arthur V. White, Toronto, wished to safeguard the public in the matter of electric heating. So much had been stated to lead the people to believe that it was both feasible and economical that he believed the meeting should place on record the opinion that it was not so. Toronto alone would require all the power that is now available for heating alone.

H. R. Safford, Montreal, in discussing John Murphy's paper on railway electrification, expressed the opinion that the facts presented were both important and deserving of greater consideration. The electrification of railways is carried out because of certain local reasons. In New York it was a matter of the abolition of smoke and other civic causes. Other lines were new and some were specially adapted for electrification. So that the question should be considered in each case upon its merits and not on general principles.

J. Blizard, Ottawa, thought the whole question of fuel deserved a fuller and more carefully considered investigation. A census of fuel requirements and resources should be made. Before we could intelligently apply adequate remedies it was necessary, in his opinion, to collect every possible fact, so that the problems might be attacked in a comprehensive and scientific manner.

A committee of the council of the society was appointed to consider the conditions existing in Canada. They will have access to all the papers and discussions. and will digest them. The report of the committee will go forward to the government.

The final meeting of the session took the form of a smoker at the rooms of the Toronto branch of the society.

The last pier of the Central Canada Railway bridge over the Peace River at Peace River, has been set up. When completed, the Peace River Railway bridge will be one of the largest in Western Canada, being 1,735 feet long from abutment to abutment and 77 feet above low water level. The three central piers in mid-channel were built in 40 feet of running water, at low water mark.

GARBAGE AS FEED FOR HOGS

The Commission of Conservation, Canada, has recently issued a most interesting and comprehensive pamphlet on the methods and success of feeding garbage to hogs, employed in the cities of Saskatoon, Sask., Worcester, Mass., and Grand Rapids, Mich.

The two American cities were visited during the summer of 1917 by Prof. G. E. Day, of Guelph. In both plants the garbage is fed raw. In the Saskatoon plant, however, the garbage is boiled and mixed with a small amount of grain. This is probably the best plan of procedure in Canada where sterilization is required and the feeding of garbage to swine is conducted under license and inspection. These licenses are issued through the Veterinary Director-General at Ottawa.

Arthur Wilson, medical health officer at Saskatoon, states that a conservative estimate would be at least 1,600 hogs fattened and marketed during the year.

In that city the feeding of boiled garbage to hogs according to by-law has proven eminently successful, he reports.

At Worcester, Mass., a city of about 170,000 inhabitants, the garbage is fed at the home farm, an institution for the city's indigent poor, which contains about 600 acres, and is situated about three miles from the city.

In 1917 the home farm was getting only about 60 per cent. of the garbage, the remainder being handled by private individuals who had been granted licenses by the city. These private collectors were getting the best of the garbage, and the part most cheaply collected, because they took it from hotels, restaurants, and large boarding houses.

The superintendent, Thos. Horne, stated that fifteen tons of garbage per day would maintain three thousand pigs of all ages. According to his calculation, one ton per day would be sufficient for ninety fattening pigs. This is nearly three times as high a valuation of garbage as was made by Messrs. Brown and Hartman, at Grand Rapids. The method of feeding may partly account for the discrepancy.

The pens are floored with cement and about half of each pen has a plank over-lay for the bed. The garbage is fed on the cement floor next to the feed passage and there is also a cement trough for water. For out-door feeding, wooden platforms, built on runners, are used.

Mr. Horne claims that garbage, few raw, is a perfectly balanced food for pigs. The herd was destroyed by foot-and-mouth disease in 1915, but cholera is prevented by immunization.

Alvah Brown was the pioneer in garbage feeding at Grand Rapids, Mich. The farm where the garbage is fed is about 30 miles from the city, of sandy soil, in a thinly settled district. The present stock on the farm comprises 300 cattle, 400 sheep, and 700 pigs. There is not quite enough garbage to supply the requirements of all the stock on hand, and a certain amount of hay has been purchased for the cattle and sheep, though it is claimed they prefer garbage.

The garbage is fed raw. Mr. Brown attempted to cook it, but claims he found it decreased the value of the garbage as food, and increased the cost. The company is satisfied, therefore, that it pays better to feed the garbage raw and treat the hogs as a precaution against cholera. In summer, Mr. Hartman, who is managing the farm, recommends feeding pigs on the ground, and shifting their location occasionally so that there is no chance for any considerable fermentation of the material on the

(Continued on page 306)

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Principal Contents of this Issue

THE CONSERVATION OF WATER POWER

THE question of conservation has to do with the policy not only of the governments, federal and provincial. but also of the people at large, with regard to those resources, useful to man, which are supplied by nature in form easily adaptable to immediate utilization, and particularly with regard to those natural resources, not uniformly distributed, which are limited in extent or in quantity.

Among such natural resources are the minerals in the earth, the forests growing upon the earth, and the waters flowing over the earth. Whether applied to any or all of these, a policy of conservation should manifestly be directed neither to a locking up or withdrawal from use on the one hand, nor to an indiscriminate or wasteful utilization upon the other hand. Economy in its best sense should prevail, but an economy which has regard for both the present and the coming generations. These natural resources are placed by nature for the use of man —the man of to-day and the man of the future. Where present and future interests conflict, those of the present are paramount. It is not justifiable unduly to place burdens and restrictions upon the present generation out of regard for those to come after us nor unduly, by present extravagance, to impose unnecessary burdens upon the future. More than that, neither desires for the present nor for the future should be made the justification or pretext for measures in conflict with the fundamental laws of personal and property rights which are, under our constitutional government, the safeguards of our free constitutions.

Conservation, then, should denote the policy of the economical utilization of these natural resources, and of the utmost protection, within the law, of such economy, consistent with the needs of the present and of fuure generations.

The two great natural sources of energy available are coal deposits and water powers. The known supply of coal, while sufficient for a few centuries to come, assuming that the present rate of consumption continues, is in fact limited, as its cost to the consumer gradually increases as the supply diminishes. While the cost of developing water power is considerable, the development and transmission of electrical energy has made water power development feasible as a business proposition, as against the cost of steam power, to the extent that the amount of water power which is still undeveloped, but which could be economically developed at the present time, amounts to millions of horse-power. As fuel grows scarcer and as the science of electrical generation and transmission progresses, further water powers, now merely potential, will be available for the market.

Because it is inexhaustible and because its use replaces that of another and exhaustible natural source of energy, water power is the most potent of all natural resources, as a subject and agency for conservation. In the case of a limited, exhaustible, and rapidly diminishing supply of a natural resource, such as coal deposits, the forces of conservation should be directed to the prevention of use as far as consistently possible. But the correct view of conservation inevitably leads to the demand that, in the case of water powers, there shall be encouraged and promoted the greatest and most immediate use possible.

ONTARIO'S MINERAL PRODUCTION

THE statistics in the preliminary statement of Ontario's mineral production for 1917, cover the output of metallic and non-metallic mines, quarries and other excavations, and also the primary products of works and plants treating materials of provincial origin. The figures are subject to revision, and are issued as soon after the completion of the year as possible, for the information of the mining community and the public generally. Mr. T. W. Gibson, deputy minister of mines, Ontario, and his staff are to be commended for the rapid and careful collection and prompt publication of their statistics. Such action materially enhances the value of the figures. The total production last year, having a value of $71,060,942, shows an increase of $5,757,120 compared with that of 1916, and marks a new high point in the record of Ontario's mining industry. As Mr. Gibson says, "an expression of satisfaction may be permitted in this successful effort to bring the minerals of the province to bear with added weight in the great struggle of Britain and her Allies for justice and freedom."

Some interesting particulars are given in the preliminary statement regarding nickel and copper. The output of nickel-copper matte in 1917 was 78,897 tons as compared with 80,010 tons in 1916. The nickel content, 41,887 tons, was greater, but the copper content, 21,997 tons, less than in that year, which may be explained by the fact that the bulk of the Canadian Copper Company's production was from the Creighton mine, the ore of which is well known to contain much more nickel than copper. During the year, 1,453,661 tons of ore were smelted at the Copper Cliff and Coniston smelters.

The Royal Ontario Nickel Commission in its report on the nickel industry, issued early last year, estimated the known reserves of nickel ore as 70 million tons, but it is

believed that the results of diamond drilling since the issue of the report have added nearly 100 per cent. to the quantity. Explorations at the Levack, Frood Extension, Murray and Falconbridge deposits has much extended the limits of the ore bodies. The refinery of the International Nickel Company of Canada at Port Colborne is well on the way to completion. It will have a capacity of about 10,000 tons of nickel per annum, and a relative quantity of copper.

Although the nickel-copper mines of Sudbury are the chief source of copper in Ontario, there are other deposits of non-nickeliferous copper ore from which shipments of ore and concentrates were made in 1917 to the extent of 4,173 tons, containing 431,402 pounds of copper, valued at $89,380. In addition, 110,476 pounds were recovered from silver ore and gold slag treated in United States refineries. On the Hudson Copper Company's property in Galbraith township a handsome showing of copper glance has been uncovered. The average price of copper in 1917 was 27.18 cents as compared with 27.20 cents in 1916. Since September 21st the price has been, as fixed by the United States government, 23½ cents per pound f.o.b. New York. Ontario's mineral production, large as it is, will increase rapidly as the undeveloped resources are harnessed with capital and labor.

PERSONALS

Lieut. E. M. Royce, formerly of the Canadian Artillery, now of the Royal Engineers, is gazetted deputy assistant director of inland waterways with the Imperials.

W. H. Winterrowd, formerly assistant chief mechanical engineer of the Canadian Pacific Railway, has been appointed chief mechanical engineer to succeed W. E. Woodhouse, who has resigned.

Lieut. A. H. Parker, who before going overseas was on the staff of the Good Roads Department at the Parliament Buildings, Toronto, Ont., is now serving with the Royal Engineers, working on the lines of communication on the Macedonian front. He graduated in civil engineering from the University of Toronto with class '14, and had qualified as a lieutenant in the Canadian Expeditionary Force before training in England for an Imperial commission. On completing the course he was one of three Canadians chosen out of a class of 80 for service in the East, and went out to Saloniki with the 37th Army Troop Company, R.E., in December, 1916.

OBITUARIES

Edward Fraser, superintendent of the St. James sub-station for the Winnipeg Electric Railway Company, was electrocuted while at work on March 24th.

E. S. Prentice, who passed away at the Royal Jubilee Hospital, Victoria, B.C., on March 12th, after an operation, was at one time consulting engineer to the Transvaal government and member of the Institute of Civil Engineers. He was 58 years of age and the eldest son of the late Judge Prentice of the Middle Temple, and Mrs. Prentice, Surbiton, Surrey, England. For the last six years he has resided at Ganges Harbor, Salt Spring Island. He leaves a widow and two sons.

Flight-Lieut. C. G. Wheelock, son of C. R. Wheelock, president of the Ontario Good Roads Association, was drowned at Dartford, England, on March 19th as the result of a Flying Corps accident. He enlisted as gunner in the 14th Battery, Toronto, in April, 1914, leaving the University of Toronto, where he was just completing his fourth year in the civil engineering course. He reached France in September, was promoted to bombardier, and served about twenty months at the front there and in Belgium. He then returned to England to train for a commission in the Flying Corps and was awaiting orders to return to France in the 63rd Squadron, R.F.C.

W. F. TYE WINS GZOWSKI MEDAL

An interesting ceremony took place at the meeting of the Canadian Society of Civil Engineers at Montreal on March 28th, when the Gzowski medal for the best contribution to Canadian engineering literature during the year was presented to William Francis Tye, a past president of the society, and late chief engineer of the Canadian Pacific Railway, for his recent paper on "Canada's Railway Problems." The presentation of the medal was made by another past president of the society, Sir John Kennedy.

OTTAWA BRANCH, CAN. SOC. C.E.

The year book of the Ottawa Branch of the Canadian Society of Civil Engineers has just been issued. The proceedings committee announces that through the courtesy of J. B. McRae, who designed and superintended the construction of the new pumping plant of the city of Ottawa water supply system, a visit to these works will be made on May 18th. The publicity committee announce that special arrangements have been made for fuller press publicity through reports of meetings, special news write-ups, etc.

GARBAGE AS FEED FOR HOGS

(Continued from page 304)

feeding grounds. Mr. Hartman claims that he has bought thin hogs at twelve cents per pound and sold them finished at eight cents per pound and still made a good profit on the operation.

The city has made certain rules defining what is meant by garbage, and the method which the householder is required to follow in his disposal of it. Citizens are prohibited from disposing of garbage to any person or persons other than the city. The city collects the garbage by means of nine wagons equipped with covered steel tanks and one auto truck. The tanks are approximately ten feet long, four feet wide, and two feet deep.

Quite a number of cities in the United States dispose of their garbage by a method similar to the one described.

Messrs. Hooper and Miller, 40th Street Station, Denver, Col., are looked upon as about the oldest and most successful men in this business.

The Department of Agriculture of the United States has under way a study of the situation, including the best methods of handling, the feeding and fattening of stock, the most efficient and sanitary arrangement of equipment, the comparative value of garbage as a hog ration, and the economy of garbage disposal by feeding to hogs compared with systems of disposal by incineration, rendering, dumping, or burying. The investigation will extend to all parts of the United States.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Plan for Emergency Development at Niagara Falls

Includes Temporary Intakes Along Crest of American Falls, Deepening of American Channel, Weir for Diversion of More Water to American Channel, Intakes Along Crest of Horseshoe Falls on American Side and Littoral Penstocks or Canal on Canadian Side, With Dam Extending from Canadian Shore

By W. W. YOUNG
Consulting Engineer, New York City

THE objects of this article are to outline a brief summary of: (1) Some reasons necessitating an emergency development of Niagara. (2) Some conditions essential for the conception of any development. (3) One of a number of definite plans for such development.

All the power now permitted to be developed under the international treaty is used, and, though numerous steam plants have been added, the insistent power demand is so far from being satisfied that there is a vital power famine which has attracted international attention.

The improvements in the transmission and wide use of electrical power and its products, particularly in transportation, metallurgy and electrochemistry, have rapidly made it of very great value. It is said if the nitrate trade were stopped by Chile or by submarines, or by both, that the Allies would be defeated in sixty days. We hope this is not true; we know it would not be possible if Niagara were harnessed, for, even though the power now be used only to make the fertilizer which Canada needs, it could be quickly and easily adapted to the requirements of explosive nitrate manufacture.

With factories shutting down for days at a time, may not the time come when Canada can obtain no coal from the United States? The utilization of Niagara means not only a saving of coal and of cars, but also the release for urgent needs elsewhere of thousands of miners. At twice the rate of locomotive efficiency, it would replace the continuous movement every day of thirty trains of two thousand tons each, and would free these and 15,000 miners for urgently needed aid to the Allies.

Niagara Falls—Cross Indicates Luna Fall—American Falls in Foreground, Canadian (Horseshoe) Falls in Rear

Sight-seeing and touring might be discouraged. The best viewpoints in Canada are barricaded and the tunnel under the Horseshoe closed for military reasons. At what more opportune time than when both countries are united in one vital, common purpose, could co-operative development be proposed and effected?

The discharge of the Niagara River varies from 314,000 second feet and more (1856) to 158,000 second feet (1902) and less, and recently from 265,000 s.f. to 180,000 s.f. within a day's time. The conservative average discharge, 204,000 s.f., given in the Canadian report, is attainable for subsequent permanent development, and also would improve navigation, by International headworks between the Buffalo Breakwater and Goat Island. The sixty-year discharge profile shows periods of years when the average monthly discharge is never under 200,000 s.f. In order to take advantage of prevailing high flows, and because of the latitude of subsequent deductions and of the preliminary nature of the discussion, this last round figure will be used.

From the flow of Niagara River at least twenty per cent. must be deducted for diversion losses and aid to

caring for ice. At least twice this will be required at times, but for periods too short to justify so much reduction in installation. During the war, when viewpoints are barricaded, travel discouraged and resources husbanded, maintenance for scenic effect is ill-timed; but in the transition period at the end of the war, and later, this latter 40,000 s.f., equitably distributed, will not only improve the present and former scenic effect, but—by throwing the heaviest flow over the margins—will stop and tend to remedy the increasing self-defacement of the

Plan of Niagara Falls, U.S. Geological Survey—A, G and C Indicate Littoral Penstock Installations Proposed by Mr. Young; D, Vertically Controlled Deflector; S, S, Temporary Emergency Main Spillway Section

Horseshoe, where what may occur is exemplified by what appears at the next bend below, where the river turned a similar angle and narrowed itself from the wide whirlpool section to form a series of rapids but three or four hundred feet wide. Into such a narrow self-dug gorge the Horseshoe seems, with increasing rapidity, to be surely disappearing.

Most of the main existing plants at Niagara Falls require tunnels or canals through town,—valuable for scenic preservation or economic use of head, but too slow in construction for war development, which must be almost instant to serve at all. We, therefore, are not further concerned with them except to deduct the sum of existing plant and canal diversions to get the net flow of the river for our problem. The treaty allows some canal and sanitary diversion, etc., and 56,000 s.f. beside. Hence, at least 60,000 s.f., in round numbers, should be deducted for existing canals, plants, etc. Deducting from the useful flow, taken as 200,000 s.f., the minimum installment allowance for ice, etc., and for installations now operating, a total of 100,000 s.f., we have the other 100,000 s.f. remaining. The fall, about 160 feet, means approximately 1,800,000 horse-power.

Another condition essential to a clear grasp of the situation is the treaty with the United States, which, in effect, forbids further developments of boundary waters until after a year's notice of its abrogation, unless, of course, this be waived by mutual agreement.

The proposed developments of the rapids below the falls by tunnel, long penstock or dam, are not quick enough to make them of any war value, for so much labor will have to be put into them that the war may be over before it could be gotten back by the added force and efficiency given to other labor. There is nowhere else so quick and cheap a way to get vast power in the heart of the market as to apply machinery to the dam which nature has already installed at Niagara!

Plan for Rapid Development

Almost every way conceivable for partial peace-time development has been studied or suggested, but no plan for complete development except the following, which was proposed by the writer at a meeting of engineers in January and brought to the attention of those in touch with the engineers of both governments during the following month. It is at least better than no development at all, and has been definitely set forth to meet such a catastrophe as the termination of nitrate shipments would produce, or as really now exists, could the people but realize the importance of the manufacturing emergency.

As a minor example of one method, were it desired to develop five or ten thousand horse-power, it would be no feat to block the channel between Luna and Goat Islands—not fifty feet wide nor two deep—install penstocks, etc., on or near the face of Luna Fall, and then remove the obstructions. This might temporarily murder the scenery, but things far more precious are being murdered for the lack of power. If more power were wanted, nobody could gainsay the feasibility of stopping the inter-island escape channels and diverting to the Luna Channel all the water flowing between Green and Goat Islands.

Similarly, the American channel passes but a twentieth to a thirtieth of the total river flow and is under 170 yards wide and but little over three feet in mean depth near the head of Goat Island. Here it would be no great feat to hold about 170 cubic yards of obstructions of an easily re-

movable character, until penstocks with a proper removable intake dam had been placed just behind the margin of the Falls or a distributor emplaced along the bank. Then the removal of this small obstruction from water moving less than four miles per hour, would free 9,000 second-feet or 160,000 horse-power for these penstocks.

When more power were wanted at this point, three or four times this amount, or more *ad libitum*, could be sent down this American mill race by deepening the channel and extending a weir averaging under three feet high from the head of Goat Island southerly by southeasterly to the International Boundary, without interfering with the plants on either shore. Instead of literally placing obstructions, particularly in an installation of this size, a dam with movable gates could be used at the head of Goat Channel. The rate of progress for this part of the work would exceed the progress on the machinery.

The development of this, say, 600,000 h.p. would make it easy to bare the Terrapin Rock end of the Horseshoe, where further penstocks could be placed and then some water diverted toward them (by placing a gated dam on the shortest line between the Horseshoe and the Canadian shore below the Canadian Niagara Power Co.) to develop 300,000 h.p., more or less, depending on the amount of power wanted for development below the dam by an installation of overhanging penstocks and littoral penstocks or canal. The International Railway plant could be compensated by flume or electric power.

The Canadian and United States Government technical reports favor putting a protecting weir just above the apex of the Horseshoe; but an engineer, attempting to elaborate on this plan in the press, was ridiculed as attempting the impossible in such a raging torrent. If there were a risk of failure in this step of the way here proposed, there are others to turn to; but to divert a torrent is a thing that has been done and can be done again with greater certainty. Anyone, who has pushed a canoe over rapids or falls two or three times its depth, or has ever travelled the rapids of the St. Lawrence, knows that a boat can be held in swift water, whether from a cableway or otherwise, and from the boat the rocks beneath can be drilled and fastened into at any place to any extent, if suitable pier frames and works for movable gates cannot otherwise be held and set.

The mere closing of the gates above, while it will provide a way to set the intake openings for 900,000 h.p., more or less, on the Canadian side, will not divert the maximum quantity to the Terrapin end nor will their opening supply enough water for the wheels and a full flume or canal along the cliff, unless the Horseshoe channel be obstructed. The long weir or dam above the apex, favored by reports of both governments, would therefore be constructed to distribute properly the remainder of the water between the Terrapin penstocks and the proposed Canadian shore works. From this dam any water not taken will be utilized, as has been done similarly elsewhere, by river bed shafts and tunnels with unseen power plants under the floor of the rapids, which would develop secondary power in the final post-bellum design. Otherwise, the power as mentioned is equally divided by the international boundary lines.

It is evident this plan can be varied to any extent, both as to quantity or so that most or all of the development is either on the Canadian side or in the United States. Thus, by abrogating the treaty, either country might develop at will; but the treaty covers the St. Lawrence, and friction would result, not to mention the year's notice the treaty requires.

Regarding conversion to permanent international development by equal flow canals to the escarpments behind Queenston and Lewiston, the U.S. Congress has been advised by the highest officers against permitting fractional developments of either fall or flow, while the Canadian authorities have taken the lead in seeking to get all of the inter-lake fall possible and in opposing as wasteful any developments using only part of the attainable fall. Several hundreds of men are now at work for the Hydro bringing to completion a construction which will give double the power they now have developed in Canada.

Immediately upon the conclusion of peace, the permanent development must be made, reserving enough flow for ice and a uniform flowage over both falls equal in thickness to that on the American. Canada has already taken the first step in this direction by building a power canal over the escarpment to get all possible of the 326 feet of inter-lake fall. The United States cannot do better than follow her example. While 210 feet can be had from the hydraulic companies' canal, less is available for the existing tunnel and enlargement is expensive; and, while the development of the rapids will (considering friction, backwater and ice) give 80 feet head, the total is scarce 290 feet, while the fall from Chippewa to Queenston is over 312 feet, which (in combination with a regulated flow of 204,000 second-feet) gives over 7,000,000 continuous horse-power!

The larger electric generators are the more economical. There are few on hand, and although the plan outlined makes it feasible and handy to use every possible size, many must be made. The biggest now is 90,000 h.p., and would ordinarily take a year to make. The wheels, penstocks and controlling dams can soon be ready. By priority orders, the United States government could be of great aid in speeding up the electrical machinery.

Legislation should be obtained proposing the prompt draft and conclusion of a new treaty to exclude Lake Erie and Niagara River from the present treaty, and naming an authority to develop them for war use,—a single plenipotentiary, as proved best at Panama, or at the most, one from each country.

Among such able public servants as former United States presidents and British ambassadors are men who have the confidence of the people in both countries, and have pre-eminently the judicial temperament so essential to prevent injustice to individuals and corporations affected by their acts, and to give the public confidence that this great national resource would be strictly conserved solely for public benefit. Nor need a representative be sought overseas, for pioneers in the public control of hydro-power in the Dominion have the knowledge, experience and personality for the undertaking. Experience has shown that a single head, or at the most two, is vital to prompt decisions and the progress needed to make Niagara a great and timely help in winning the war.

Conclusion

It is, therefore, evident:—

(1) That power, coal, transportation, nitrate and general war manufacturing conditions necessitate an emergency development of Niagara.

(2) That a clear grasp of conditions can be had by considering that while rapids and other sites require equal machinery and a tedious dam besides, Niagara's nearly two million horsepower is larger than them all, located in the centre of manufacturers and transportation, and with a dam built and waiting.

(3) That this dam is favorably formed for the quick application of power in many ways; for instance, by making a millrace of the American spillway and constructing a corresponding littoral development in Canada.

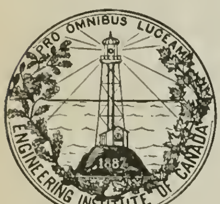
Will the people of the United States and Canada allow the prodigious waste at Niagara to continue for years more after nearly four years of war have already passed?

Letters to the Editor

Proposed Emblem for Institute

Sir,—I have placed the enclosed sketch before the committee of the council of the Engineering Institute of Canada, as a design which seems to me to be suitable as an emblem for the Institute.

The main emblem is a lighthouse placed on a rock and shedding its welcome light over an expanse of sea. At the lower edge is the name "Engineering Institute of Canada." Above is a motto, "Pro Omnibus Luceam," let me shine for all. On the left, a bough of English oak, and on the right, one of Canadian maple. On the rocky base you may notice the date of the foundation of the society, 1887.



The oak leaves are to remind one of our connection with the British Institution of Civil engineers, and of the many distinguished British engineers who have become Canadians.

A lighthouse (Pharos) is almost a living being. It is one of the choice products of the engineer's skill, and one of the few that have never been turned against humanity. Its rays either show the way to safe harbors or they mark the hidden dangers of the route. Does it not seem aptly to express the ideals of the profession?

Publication of the enclosed sketch may bring out desirable discussion and perhaps other designs from the members of the society.

LOUIS G. PAPINEAU, A.M.Can.Soc.C.E.
Montreal, P.Q., April 8th, 1918.

Power Possibilities on the St. Lawrence River

Sir,—An interesting pamphlet recently issued by the Commission of Conservation deals with the "Power Possibilities of the St. Lawrence River." Arthur V. White, the consulting engineer of the commission, who prepared this pamphlet, very succinctly shows the enormous power going to waste between Lake Ontario and Montreal. Taking the minimum flow of the St. Lawrence, and disregarding the enormous increase available by regulating dams on the Great Lakes, it is possible to provide, with the "diversity load factor," over three million horse-power —a quantity about eight times greater than the present combined developments of the Canadian Niagara powers and the Shawinigan Company with its subsidiaries.

Despite these vast power possibilities, Mr. White points out that the power shortage in Eastern Ontario is acute,—as indeed it is also in the Niagara District, with all its world-famous facilities for hydraulic power. Some 20,000 h.p. could be absorbed immediately by the Eastern Ontario municipalities adjacent to or within easy transmission of the high-tension power line of the Cedars Rapids Manufacturing and Power Company, which in its course to Messena, N.Y., passes through the Eastern Ontario territory most affected by this power shortage. Deploring this state of affairs, the Commission of Conservation points to the fact that some 65,000 h.p. of electrical energy developed at Cedars Rapids, near Montreal, is being exported to the United States for manufacturing purposes, and incidentally part of this load supplies certain municipal requirements in New York State.

If the Cedars Rapids Company is transmitting power through Eastern Ontario on its way to Messena, one is naturally tempted to enquire why on earth this transmission line cannot be tapped to serve the Ontario municipalities so urgently in need of hydro-electric power. Briefly stated, it is probable that the Cedars Rapids Co. has no desire to extend its system into Ontario at great expense and under the covetous opposition of the Ontario Hydro-Electric Commission, to be no doubt finally confiscated by the said commission. It is a well-known fact that the Cedars Rapids Co. is selling large quantities of power for export and to Montreal consumers at prices below what the Ontario Hydro-Electric Commission is selling for, and this company is no doubt willing to sell to anyone who will "pay cash and carry"; but to venture into Ontario as a distributor of power would be showing a reckless disregard for the interests of the investors, who are to be congratulated in having kept themselves beyond the aim of the confiscatory tendencies of Ontario "Bolshevism."

Returning to the lament of the Commission of Conservation on the subject of power exportation, Mr. White suggests what could be done in Canada with the 65,000 h.p. going to Messena. It could supply, he says, at cheap rates, all the light and power required for a manufacturing city of 300,000 inhabitants; or, if distributed through Canadian municipalities, it would supply light and power to some thirty-five manufacturing cities of 10,000 inhabitants each; or, it would practically take care of one-third of the present demands of the Niagara system of the Hydro-Electric Power Commission.

Of what United States communities could do with the enormous quantities of anthracite and soft coal that they export to Canada, we are not advised by the commission. But referring to this question of coal, Mr. White recognizes our dependence upon the United States, and further states that Canada should appreciate the fact that the United States has been dealing generously with her. "Canada," he says, "however, must conserve against the day of her own need such resources as are available for barter."

We wonder if the Commission of Conservation is aware, or realizes, the amount of hydro-power that is available, and whether in the face of such enormous unharnessed resources we are to remain in wait for the day that Canada's population increases sufficiently to warrant their development. We admit that we are contending with power shortages, yet these shortages are too insignificant for us to consider the development on such a huge scale as required with any one of the St. Lawrence powers. The Commission of Conservation should realize that no government or private capital can afford to develop, say, half a million horse-power with a market for only 50,000 horse-power.

We must, therefore, co-operate for an understanding, with a view to selling sufficient power by export to warrant harnessing potential forces, part only of which we so urgently need ourselves.

Taking Mr. White's figures at 65,000 h.p. being equal to the needs of 300,000 urban inhabitants, it is well to note that we have as Eastern Canada's share of undeveloped power some 7,000,000 h.p., capable of supplying the needs of over 30,000,000 inhabitants of manufacturing centres:

St. Lawrence	3,000,000	horse-power
Niagara	2,000,000	"
Ottawa	1,000,000	"
St. Maurice	1,000,000	"

It is, therefore, not quite clear just why the Commission of Conservation in its eagerness to conserve would, indirectly perhaps, prevent utilization as exemplified in their opposition to application recently made to develop Coteau Rapids on the St. Lawrence. The commission took a similar obstructionist attitude a couple of years ago in regard to a proposed development of the Long Sault Rapids on the St. Lawrence.

To point out the alarming power shortage and to oppose private enterprise in its development, all in the one pamphlet, is an attitude upon which the commission owes more explanation to the public.

R. O. SWEEZEY, B.Sc.,
Consulting Engineer.

Montreal, P.Q., April 5th, 1918.

RESEARCH COUNCIL GETS APPROPRIATION TO BUILD LIGNITE BRIQUETTING PLANT

The Advisory Council for Scientific and Industrial Research has been informed officially that the government has approved the council's recommendation that a plant be erected in the province of Saskatchewan for briquetting lignite. The government has provided a sum of $400,000 for the construction and operation of the plant.

In this undertaking the Dominion Government is acting in co-operation with the governments of the provinces of Saskatchewan and Manitoba.

The council has received a request from the Ontario Government asking that R. A. Ross, E.E., one of the members of the council, be appointed to act with Arthur Cole, C.E., as a committee to take immediate steps for the development of the peat bogs of Ontario, and the production from them of a merchantable fuel. The Research Council has concurred in these appointments and the investigation will be proceeded with.

Leslie R. Thomson, C.E., who is at present on the staff of the Dominion Bridge Company, has been appointed as secretary to the council.

SASKATCHEWAN BRANCH, CAN. SOC. C.E.

A special meeting of the Saskatchewan Branch of the Canadian Society of Civil Engineers was held in Regina to deal with the first of a series of papers devoted to the subject of power. J. D. Peters, electrical superintendent of Moose Jaw, gave a paper on load factor and diversity factor, and their effects upon the production of power. In the discussion following the paper, members expressed the opinion that a great saving in power and coal might be effected by the establishment of central power distributing stations at the various coal fields. The engineers in the study and investigation being carried on now hope to arrive at some conclusion which will dispel the popular belief that Saskatchewan cannot produce cheap power because of the absence of large water powers.

CATALOGUES WANTED

The British American Nickel Corporation, Sudbury, Ont., advises *The Canadian Engineer* that it possesses practically no catalogues of engineering machinery and materials manufactured by Canadian firms, although the company is starting to build a $3,000,000 plant for the smelting and refining of nickel.

ELECTRICAL THAWING OF WATER PIPES*

By Fred C. Adsett
Hydro-Electric Power Commission, Trenton, Ont.

THE extremely cold weather this winter arrived early in December, before the snow came in sufficient quantities to afford a protection to the earth. Thus the frost got off to a good start in its descent through the ground, and soon succeeded in gripping the water pipes in a frigid embrace of no mean consequence. In view of the extensive trouble experienced on this account with the freezing of water services throughout the country, a description of the thawing apparatus used at Trenton, Ont., might be interesting.

Electrical thawing of water pipes comes near to being the ideal method of overcoming the difficulty. There is no digging, no splitting of pipes, nor shutting off of the water to other consumers. All that is necessary is to connect a wire to each end of the frozen pipe and pass sufficient current through the circuit. The chief drawback is the extremely severe weather at times encountered by the linemen while at this work.

The thawing outfit used at Trenton consists of a transformer, cut-out, water resistance, ammeter, switch, and reels of wire. A 15-kw. transformer has been used all winter, connected to give 110 volts on the secondary side. To regulate the current, a barrel of salt water is provided; the resistance used, however, is generally very small. The switch is on the secondary side; the ammeter is of the portable type. Near the transformer is a small reel of 8-w.p. wire; this wire is used to connect the cut-out to the live primary. Connection is made to a bare primary without danger by a clip device on a long wooden stick.

At the back of the sleigh are two larger reels each containing five hundred feet of No. 1 copper. These reels are turned by a crank when the wire is to be rewound. The primary distribution system in Trenton is 3-phase, 4-wire, with 2,200 volts between any phase and the neutral, or ground. Hence only one side of the transformer primary need be connected to the line. The other side is permanently grounded to one of the large secondary wires. Two men are required to operate the outfit efficiently; sometimes three are used. The entire equipment is hauled by one horse.

Practically all the trouble encountered this year has been in wrought iron service pipes. These are generally ½ inch pipes, but occasionally are 1 inch and two inches in diameter. For the ordinary ½-inch service pipes we have found that 180 amperes are the most efficient. This current is sufficient to heat the empty pipes to about 200° F. in fifteen minutes, but with water running in the pipes, this temperature will not be attained. At times, however, obstacles are encountered, such as where the water is frozen in the brass shut-off cock. For thawing services only, and where the main is free from ice, the two secondary wires may be attached at two different houses that are without water; both are thus thawed out at the same time.

The resistance of the main between the two services is naturally very small. Sometimes as many as six or eight services may be thawed at one set-up. To thaw a main, care must be taken to have one wire connected ahead of the freeze-up, and the other on any convenient lawn or house tap along the main. At times it is necessary to

*From the Bulletin of the Hydro-Electric Power Commission of Ontario.

attach to the curb cock outside, which is done by lowering the ordinary turn-off key with connection at the top end of it.

To thaw larger pipes a 25-kw. transformer is hauled out on another sleigh; this has not been necessary this winter. As high as 200 amperes have been taken from the 15-kw. transformer when necessary, care having been exercised to not expect too much of an overload from it. The 2-inch pipe requires from one to three hours to heat up.

The secondary wire is attached to the water pipes by being wrapped with a short piece of No. 8 bare aluminum of which there is a supply of scrap on hand. Variations from the usual sometimes occur. At times a transformer on the line is handy and may be used in place of that on the sleigh. In one case, after disconnecting the ground connection, we have attached the line side of the 110-volt service in the cellar direct to the water pipes. In this way the current flowed to the ground connection of a neighbor and registered 62 amperes without resistance. This house had No. 6 wire in the service conduit and was fed from the 20-kw. transformer.

Nor is the use of electrical thawing confined to water pipes alone. We frequently are requested to thaw soft-water pipes, soil pipes, and even sewer pipes. In Guelph, last winter, an underground cable was thawed in a conduit which had been flooded and frozen. Fifty amperes loosened this cable in thirty minutes, after steam had been tried for two days.

As the electric and water utilities both come under the one management in Trenton, some thawing jobs are charged direct to the water department. In cases where the consumer bears the expense, the time of the men and horse and the current used plus a small profit for depreciation of the apparatus, has averaged in the past between $1.50 and $2.25. This compares very favorably with the prices in Binghamton, N.Y., where the average return for each job was $13 with a minimum of $10.

The average number of thawing jobs completed in one day would range from six to twelve, depending upon how they might be grouped. Where the electric department is entirely distinct from that of the water department, there should be a good revenue netted from this work. There is also the satisfaction of supplying a timely service to the people.

RAILWAY EQUIPMENT CONTRACTS

The government has given the following details in the House of Commons regarding the $32,966,515 orders recently placed for railway equipment:—

Canada Car & Foundry Company, 5,000 forty-ton steel frame box cars, $13,750,000; National Steel Car Company, 1,000 cars, $2,750,000; Eastern Car Company, 750 forty-ton flat cars, $1,777,800; Eastern Car Company, 650 fifty-ton coal cars, $2,066,675; Hart-Otis Company, 250 side-dump cars, $760,000; Hart-Otis Company, 200 side and centre-dump cars, $625,000; Pressed Steel Car Company, 25 general service tanks, $134,956; Pressed Steel Car Company, 25 water service tanks, $129,593; Canada Car & Foundry Company, 250 refrigerator cars, $1,024,250; Pullman Car Company, 14 sleeping cars, $502,460; Pullman Car Company, 7 dining cars, $238,700; Montreal Locomotive Works and Canada Locomotive Company, 50 consolidated freight engines, $2,900,000; 10 switching engines, $405,000; 30 Pacific type engines, $1,800,000; 50 Mikado type engines, $3,720,000; Canada Locomotive Company, 6 switching engines, $246,000; 4 narrow-gauge engines, $136,080.

MORE EQUITABLE CONTRACTS BETWEEN HIGHWAY COMMISSIONS AND CONTRACTORS*

By James C. Travilla
Consulting Highway Engineer of the Dunn Wire Cut Lug Brick Company.

THE relations of the contracting parties to a contract for highway construction are closely allied; they should be co-operative and their joint efforts should be constructive. Unfortunately, at times, the duties and responsibilities of highway commissioners are not properly interpreted, or are limited by laws which make it difficult to successfully direct, finance and construct highways on a basis equitable to both parties to the contract.

The highway commissions' duties frequently are prescribed by laws which are inadequate, inelastic or mandatory. The commissioners, in their capacity as trustees for the public in the expenditure of road funds, are not in a position to deal with contractors in the same manner as though they were directing or adjusting a private business transaction. This limitation can be appreciated only by those who have held public office. The highway commissions, in providing for the construction of a system of highways to meet traffic requirements and in keeping within the financial limitations, prescribe definite plans and specifications, form of contract, bidding blank and estimates of cost, etc. The specifications for highway construction have been very generally standardized. The conditions and stipulations entering into contracts and specifications, together with their interpretation, have not. The estimates of cost of work frequently are based on incomplete or indefinite information regarding the cost of labor and material, average haul, approximate quantities, available water supply, suitable railroad facilities for receiving and unloading material, etc. These uncertainties have resulted in introducing an element of risk to contractors bidding on highway work.

Highway commissioners and contractors in estimating cost of work have not given sufficient attention to the fixed, overhead, incidental and plant expenses, labor and material market and cost data. The result has been low estimates and low bids, with unsatisfactory results to both parties, which have brought about a desire for a more equitable contract. The fixed, overhead, incidental and plant charges are very significant items in highway construction. Under this head may be properly classed the following:—

Cost of bidding, contract bond, liability insurance, legal expenses, interest on deferred payments, discounting paper, travelling expenses, home and local office expenses, cost keeping, demurrage, miscellaneous freight and express charges, equipment charges, depreciation on equipment, moving equipment, tools lost, broken or stolen, loss due to weather conditions, damage to work by elements, pay roll expense during rainy and cold weather, watchmen, labor shortage, loss in damaged cement sacks, delays due to breakdowns and material shipments, cost of inspecting material, damage to private property, water charges, boarding and transporting men, entertainment, etc.

The above items do not represent imaginary or accidental expenses connected with highway construction,

*Paper read before the annual convention of American Road Builders' Association.

and, therefore, should be given consideration by highway commissions in preparing estimates and forms of contract, also by contractors in preparing bids.

Careful consideration should be given commissions for proper engineering service, and they should not expect or require highway engineers to design, lay out or supervise and inspect work involving large expenditures without adequate assistance or recompense. In France and England from 3½ to 6 per cent. of the estimated cost of the work is authorized for engineering service. This is money probably better expended than other sums devoted to highway construction. Too much cannot be said as to the importance of technical experience in road construction. The specification, design of pavement, supervision, inspection and final results of the work depend largely on the ability of the engineer.

Modern highway construction presents to contractors as great a number of financial risks and uncertainties as will be experienced in any branch of public work. For example, the difficulty and expense of securing labor and holding it on the job, due to the work frequently being in isolated places; the problem of material transportation by wagon, truck, tractors or light railways; definite figures cannot be prepared as to the fixed expense for car demurrage, unforeseen weather conditions, transportation difficulties and labor conditions having a direct bearing on this item; freight rates and their subjection to change have been a factor during the past year; assuring material supply by prompt unloading and storage piles; cement storage under cover and distribution of same; the expense and uncertainty of providing an adequate water supply; the difficulties and red tape in securing necessary railroad sidings and right-of-way for roads to the same; providing temporary roads and bridges during the period of construction; damage to work by automobile joy riders or from other vehicle drivers, who are selfish or ignorant of the damage it is possible to do to green construction by their unwillingness to be inconvenienced for a reasonable length of time (police powers of some kind should be granted to contractors to enforce observances of their road-closing signs and barricades); being responsible for damages to work by floods or other acts of God; specifying that contractors shall employ local labor and material; the loss of time by reason of delays in securing right-of-way, injunction proceedings, etc.; payment for work in warrants of questionable value. These possibilities in executing contracts help make the uncertainty and gamble to the contractors in preparing bids and in contracting for highway construction.

Highway commissioners have not always given sufficient attention to the proper classification of material and details of construction in preparing specifications. It is not unusual to provide for grading with no classification. This also applies to foundation excavation where no distinction is made between "wet" and "dry" excavation. The equalization of cuts and fills and proper provisions for borrow pits, disposal of surplus material and the determination of overhauls are essentials. Preparing the subgrade and compensation for removal of soft or spongy material and its replacement with durable material are items of expense that should be provided for. The problem of drainage should be predetermined, and items should be provided in contracts for tiling and ditching. A reasonable unit price should be stipulated for rolling both the subgrade and road materials. Many contracts fail to allow monthly estimates for material delivered on the job, nor do contracts provide for acceptance and final payment for part of the completed roadway. Where the work is of sufficient magnitude, requiring one or more years to complete, this provision does an injustice to the contractor. There should be a fixed unit of two to ten miles of a completed roadway accepted and final payment allowed. A reasonable retainer of the monthly estimates is desired. Ten per cent. should be considered sufficient to properly protect the commission's interests. However, it is not unusual to find the retained percentage to be 15 or more per cent.

The economic value of inspecting materials at place of loading instead of at the point of delivery would frequently result in saving time and money to both parties. The question of maintenance of roads used for hauling road material from railroad sidings and gravel pits is sometimes raised, and it is not unusual to place this burden upon the contractor.

These features of highway construction are cited to show the importance of equitable contracts between highway commissions and contractors. If the highway commissions are known to be fair and equitable in the adjustment of such difficulties as they arise, it is not unusual for contractors to submit lower bids on the work proposed. Where specifications and stipulations therein are rigidly adhered to, without reasonable adjustment of differences, according to the spirit and intent of the contract, the bids are usually higher.

In suggesting features coming directly under the direction of highway commissions in preparing specifications, contracts, and in the execution of work, there is also an obligation on the part of contractors and the material interests identified with them to be fair and reasonable in their dealings with the highway commissions. Contractors should take pride in their work, be financially responsible to carry it through, provide modern equipment and an organization of competent men; and, further, have established a reputation for doing good work. It should not be difficult to agree upon more equitable contracts when these features as set forth are fully appreciated by both parties.

At road lettings it has been the general practice to call for unit bids based upon approximate quantities. Under normal conditions this method is more satisfactory in road work than to bid a lump sum for the completed improvement. The unfortunate feature of public lettings is the awarding of contracts to the lowest bidders, regardless of their responsibility or experience. The highway commissions not infrequently figure it will be necessary to depend upon the sureties or "some angel" to complete the work.

This condition may be somewhat remedied by requiring certain qualifications of bidders as to financial ability, experience, equipment, etc., before assigning them bidding blanks. The size of the job should be sufficient to attract responsible bidders and warrant the expenditure of proper sums for modern equipment and appliances.

The officials of railroad and electric railway companies, when about to build railroads, generally invite a limited number of responsible contractors to submit proposals for the work at cost, plus a fixed sum or on a unit basis. Such contracts usually are executed without "grief" to either party.

Owing to legal restrictions placed upon highway commissions under our present form of government, this procedure does not seem possible, especially when we realize that politics have not been entirely eliminated from road construction, the limited tenure of office of public officials and the general lack of confidence on the part

of the public in its servants, regardless of their honesty, ability or unselfish efforts to faithfully carry out the trust imposed in them.

The precedent established by the American Institute of Architects in adopting standard documents, including contract, specifications, etc., and by making the general conditions and stipulations more equitable to the contracting parties, and by introducing the very important principle of arbitration, if followed by highway commissions, would result in the creation of more equitable contracts between the contracting parties. The State Highway Engineers' Association is working on the standardization of highway specifications and forms of contracts. The enactment of laws where necessary, authorizing arbitration of all questions in dispute between highway commissions and contractors is considered an essential before standard and equitable relations can be established between the contracting parties.

The suggestions herein offered for more equitable contracts between contracting parties for highway construction are not all that are desired under the present abnormal conditions of the labor and material market, which necessitate contractors assuming an unjustifiable amount of risk in signing contracts.

The recognized necessity of continuing building selective highways that will best serve the country in time of war as well as peace, and to further provide for the employment of a class of labor not adapted for work in munition plants and other industries necessary to help win the war, make it of sufficient economic importance for the prosperity of all classes of labor to proceed with the improvement of selecting highways in a manner equitable to both parties to the contract. Several methods of letting work to accomplish this end are suggested:—

The contractors to submit proposals on form provided by the highway commission, setting forth the rates of labor, estimated cost of manufacturing materials and quotations on the materials required; the bids to be tabulated, analyzed, and the award to be made on the best bid, considering all the items; the labor and material items shall not be less than the prevailing rates and quotations recognized at the time of bidding. This information should be set forth in the instructions to bidders. The contractor shall at any future time, if required, be prepared to show by what procedure said prices were arrived at. Thereafter the commissioners, on due proof of pay rolls, bills and receipts that the rates and quotations used in preparing bid have been substantially increased, shall grant a hearing to the contractor and be authorized to allow such additions to the unit prices stated at time of letting as will insure the contractor against actual loss due to the changed raes and prices, but this shall in no case cover the losses due to inefficient handling of the work or from faulty estimating of said cost. It is preferable that at the time of change in the wage scale or advance in price of material the contractor be requested to at once ask for a hearing before the commissioners to determine whether the request shall be allowed. If the commission decide that it is better to delay the work, they shall make an equitable adjustment with the contractor to cover the fixed charges, such as plant rental, overhead and incidental expenses, for the delay caused in completion of contract. It should be further provided that in the event of extraordinary conditions, such as embargoes on cars or material beyond the control of the contractor, which caused delay in the completion of the work, an allowance shall be made in the specified time limit for doing the work, and if a loss is incurred from such delay, to be reimbursed for the expense of plant rental and necessary overhead and incidental charges.

Another equitable method of constructing highways is to have the highway commission purchase and deliver road material, f.o.b. nearest railroad siding, the contractor's proposal to provide for furnishing labor, equipment and appliances, the labor to be paid the prevailing rates and the equipment at a fixed rental per diem for the actual time used, all of which is to be definitely set forth in the bidding blank, including the percentage of the cost of labor to be allowed the contractor for his profit and overhead expense.'

A method sometimes adopted in awarding contracts is to allow the contractor the actual reasonable cost of labor and material entering permanently in the work, as determined by the highway commission, plus a fixed per cent. of such work. In figuring the labor cost of highway construction the following items shall be included:—

(1) Actual pay roll expenditures for labor.
(2) Foremen and timekeeping on the work.
(3) Liability insurance paid on same.

The cost of materials entering into the work will be determined by the material, freight and hauling bills for the same. The fixed per cent. allowed to cover the profit, overhead equipment and incidental expense.

In conclusion, it may be stated the personnel of the commissioners and laws on the statute books are important factors in arriving at equitable contracts between the contracting parties. Commissioners who have had liberal business or technical training, working under reasonable restrictions and dealing with contractors of the same type, both parties appreciating the financial risk and uncertainty in entering into contracts under the present abnormal conditions, the contingent expenses heretofore referred to and the suggested methods of eliminating such risks, both parties should be in a position to co-operate in drafting an equitable contract between highway commissions and contractors.

$50,000,000 FOR RAILWAY EQUIPMENT

Parliament this week passed a resolution appropriating $50,000,000 for expenditure by the Minister of Railways on railway rolling stock, equipment and materials. The resolution as introduced called for an expenditure of $50,000,000 each year for the duration of the war and one year thereafter, but after debate the resolution was altered to cover only this year's expenditure.

Whether complete nationalization of any or all of the railways in Canada materializes this year or not, the government at any rate is standing behind the financing of all roads excepting the Canadian Pacific, and even in connection with that road the government is buying new equipment and rails, but expects to be paid for them promptly upon delivery.

Including the $25,000,000 loan provided for the Canadian Northern, $75,000,000 for the Grand Trunk Pacific, probably $10,000,000 for Canadian Northern stock, and $50,000,000 just voted for equipment, the government will spend this year on railway account no less than $160,000,000. Orders for equipment, rails, etc., to the extent of $32,966,515 have already been placed. This does not include the 100,000 tons of rails recently purchased and which will probably cost five or six million dollars. The government also expects to have to purchase ten or fifteen snow ploughs at a cost of about $100,000, 100 tourist cars for carrying troops and possibly about 20 baggage cars.

THE GREATER WINNIPEG WATER DISTRICT

By C. S. C. Landon, A.M.Can.Soc.C.E.

(Concluded from last week's issue)

THE invert or "floor" of the aqueduct is laid between profile forms and in lengths of 15 feet each. These forms are usually of wood, so that they can be easily handled, and the upper edge is shod with angle iron. The lower edge is cut to a section to conform with the standard trench bottom section and the upper edge is curved to the exact curvature of the invert section. The engineering staff set stakes every 30 feet, which establish the grade and centre-line of the top of the invert. The contractor is thus able to set and align correctly each set of invert forms. There is a copper expansion strip having a V-shaped groove which is set in place at each joint. Every 45 feet this copper joint is allowed to extend above the face of the invert haunches so as to form an over-lap with the corresponding copper joints placed in the end of the arch to follow. The inverts or pads, as they are sometimes called, are poured alternately in order to provide space to perform the screeding, floating and trowelling necessary to give the face of the invert the smoothest possible finish. When the concrete has hardened sufficiently the forms are taken off and the intermediate or closure pads are poured. The concrete in the inverts is screeded with tools made from 3½-in. x 3½-in. angle iron 16 ft. long and equipped with handles at each end. This is pulled lengthwise of the invert back and forth across the face from the centre to the sides, and the process is continued until the pad is true to form, and until no stones are visible at the surface. It is then finished with floats and trowels.

To guard against leakage at the longitudinal joints between the invert and arch joint, a strip of soft pine ⅝-in. x ¾-in. is sunk to about half its depth along the length of each side of the inverts and adjacent wood strips are abutted at their ends.

The arches are built in 45-foot lengths with a copper expansion strip at each end. The forms for the archwork are of the collapsible type, and are made of steel by the Blaw Steel Company. The inner portion of the forms is

General View of Falcon River Dyke

moved on carriers which run on a 2-foot gauge track laid upon the invert and these forms, when in position, are shaped up by means of turnbuckles attached to the carriers. The outer form is made in sections 5 feet in length, bolted together in 45-foot units of nine sections. Methods of moving these forms differ in detail according to the ideas of the contractor. On some contracts, the forms are moved in sections, on others, half of the form is moved at one time, which, of course, must be done by a derrick or other similar machinery. At the majority of camps, however, the outer forms are moved intact with a carrier which runs on a track laid along the two sides of the trench bottom.

When the concrete is being poured into the form some of the outer panels are removed and the concrete is brought up evenly on both sides throughout the entire length of the arch. As the concrete reaches this level these panels are replaced and bolted until the whole arch has been poured. Spading of the concrete is continuous during the process of pouring and, contrary to the opinion held by some engineers that setting concrete should not

Invert Profile Set. Note Excess Excavation Due to Roughing Too Close

be distributed, the portion at the top of the arch is spaded until it becomes too stiff to be worked satisfactorily. This being done prevents hair-line settlement cracks which otherwise would occur in dense concrete placed similarly. The pouring of each arch is a continuous process and must be continued until the form has been filled. The arches are poured alternately as in the case of the inverts and when sufficient time has elapsed the forms are removed and sprinkling or earth covering adopted to prevent the evaporation of the water from the concrete.

When the concrete has been completed for a distance and has become sufficiently hardened, the backfilling or placing of the protective coat of earth is begun. This work is carried out in two stages; first material is tamped into place along the base of the arch and reaching to a height of 4 feet, and then the machine backfill is proceeded with. Instructions are issued to bring the earth up evenly on both sides of the arch and thus provide lateral support. Care also is insisted on that no earth is dropped directly on the crown of the arch until the height of the backfill on the sides is high enough to bridge over the sudden weight applied. If a cubic yard of wet backfill were dumped from a height upon the crown of the arch it would cause sudden and unnecessary stresses.

The depth of the finished backfill is 4 feet over the crown of the arch and the width of the top about 8 feet with the sides sloping to the ground line. After the backfill has been exposed to the elements for twelve months and all settlement filled in, the top and sides of the embankment are seeded with a combination of seeds calculated to produce the heaviest sod and thus protect the embankment from further weathering.

Work on contract 55, which was awarded to the Winnipeg Aqueduct Construction Company, working in conjunction with the Canada Lock Joint Pipe Company, was carried on successfully during last summer. The contract price for this work is $1,308,753 and includes the manufacture of reinforced concrete pipe 5 feet 6 inches in diameter and in lengths of 8 feet each; the transportation of these and the setting of them in a trench previously excavated by the contractor; the backfilling of the trench and the final jointing of the pipe after the backfilling has

been done and the jointing of this pipe with the westerly end of the aqueduct section being built by the contractor of contract 30. This contract is 9.3 miles in length, and extends from Deacon to the Red River, crossing the Seine River at St. Boniface. The pipe line under the Seine will be an inverted syphon carried on a concrete mattress supported by piles driven to the rock.

Immediately south of the Canadian Government Railway shops in the town of Transcona, the Canada Lock Joint Pipe Co. have established a yard in which all operations of the pipe manufacture are carried on. The reinforcing steel is received and bent to shape there, and the cement and aggregate for concrete manufacture are delivered at the yards over a spur track constructed by the District.

Carrying Pipe Into Place

The yard is divided into two units, each being separate and distinct in so far as pipe manufacture is concerned Each unit has a battery of four concrete mixers near to which the aggregate is delivered. The cement is stored in weatherproof buildings within carrying distance of the mixers. The forms for pipe manufacture are set upon individual concrete footings, arranged on either side of a track upon which moves a locomotive hoist or carrier. This hoist handles the concrete buckets, the steel forms, reinforcing steel and completed pipe; in fact it is utilized for all lifting work in connection with the pipe manufacture except the loading of the completed pipe on to cars, which is done with a locomotive crane.

Concrete is carried in buckets which are made in the form of truncated cones. In the small end of the bucket is fitted a pear-shaped stopper which is raised by a separate cable when the concrete is to be poured into a form. After the filling of each form is completed the whole is encased in a canvass covering and low-pressure steam supplied from a central plant, is admitted to the form. The curing by steam is continued for 48 hours, after which the steel forms are removed and the curing by steam is continued under these conditions. When the pipe has been treated sufficiently it is carefully loaded on flat cars and taken to the open trench on the line of the work, and is lowered into the trench and placed upon a carrier running on a track and with this carrier is moved into place and aligned. The joints are brought up close but the outer portion or primary joint only is filled. The pipe is not laid directly upon the earth of the trench bottom, but is carried upon gravel placed on the earth and tamped to a depth of 8 inches. Backfilling operations follow the setting of the pipe, and when this has been in place at least two months the inner or secondary portion of the joint is then filled with the material specified for filler. The reason for proceeding with the jointing and backfilling in the manner stated is to allow for settlement and to make certain that when the joint has finally been made it will not be opened by future settlement.

The District has recently awarded contracts covering the construction of a tunnel under the Red River at Winnipeg; the building of 2.4 miles of concrete pressure pipe line through the city from the Red River to the McPhillips Street reservoir; and for the construction of an intake structure at Indian Bay. The work at the Red River crossing will consist of the driving of a tunnel through the rock under the river, at a depth of 75 feet below the ground surface and 35 feet below the bottom of the river; the excavating of two shafts, one on each side of the river, and the lining of the same; and the construction of a well or surge tank on the east side of the river.

Cast-iron pipe, 5 feet in diameter, will be used for the tunnel lining. This pipe will have bell and spigot ends, and each joint will be poured with lead. Hand-placed concrete will be poured in the space between the cast-iron pipe and the tunnel walls.

The flow of the water through that portion of the line from Deacon to the tunnel will be, for the immediate future, by gravity and as the velocity will be relatively low it was calculated that should sudden demands for water be made, as in the case of a conflagration, before the velocity of the water in the line had increased sufficiently, the supply would fall short of the quantity required and serious difficulties might arise. Consequently, the surge tank or well expedient was adopted. The tank is designed to hold enough water to take care of any sudden demand upon the line until such time as the water in the pipe has a velocity which will give an increased discharge sufficient to supply the demands upon the line. When the discharge from the pipe has become great enough to meet the demand, the well fills again and an overflow built in conjunction with the unit takes care of any excess of water caused by the surge, discharging such excess into the Red River.

It was the original intention to construct the pipe line from the Red River to the McPhillips Street reservoir of cast iron, but the price of iron has increased so rapidly that a saving of approximately $175,000 is being effected by building the line of reinforced concrete.

Drag-line Excavating Aqueduct Trench

The work consists of trench excavation, the removal of all permanent pavements crossed by the trench and the replacing of these by gravel, the supply of the pipe and the setting and jointing of it in the trench, the temporary removal and final replacing of all water mains, sewers, conduits, poles, etc., and the backfilling of the trench when the pipe has been set. There are other details, such as gravel backfill and vitrified pipe drains. A Venturi meter is to be supplied by the contractor for this work

and in addition the contract calls for the construction of a meter house and the furnishing of recording apparatus and a supply of recording dials, ink, etc., sufficient for one year of service. There will be eight Venturi meters of varying sizes at different points on the line.

Work on the intake is well under way. The main features of the work are: Construction of a reinforced concrete gate house in which sluice gates will be located, provision being made in the plans for the supporting of a crane; also two gravel-filled wing walls or dykes extending out into the lake; the rip-rapping of these; the excavation for the bed of the dykes and excavation of the intake channel and the setting of screens at the intake. All details relative to the clearing, grubbing and final clearing up of the entire site are also included in the contract.

The wing walls will serve the double purpose of reducing and regulating the flow of water toward the intake

Traveller for Moving Outside Forms

and of counteracting the action of wind and wave in the intake channel. The channel is also to be deepened and thus all water entering the intake will be deep water which will be cooler and always clearer. The aqueduct will be completed about the end of December, 1918, after which the inhabitants of the water district, which at present number 300,000, will for the first time have an abundant supply of pure soft water, highly suitable for domestic and industrial purposes.

NEW INSPECTION COMPANY

Announcement has been made of the formation of a new inspection and testing company in Canada. The promoters of the new company are T. F. Griffiths, formerly president of the Canadian Inspection and Testing Laboratories; N. H. Manning, formerly manager of the Toronto office of that firm; R. Robertson Deans, formerly assistant to Mr. Griffiths; R. J. Marshall, lecturer in ferro-metallurgy in the University of Toronto; and L. J. Rogers, lecturer in chemistry, University of Toronto.

The new company is operating under the name of the Canadian Inspection and Testing Company and has taken over the equipment and laboratories of the Canadian Inspection and Testing Laboratories, Limited. Offices have been opened in Toronto and Montreal.

The city of Guelph's estimates for this year include $20,500 for the Light and Heat Department, $20,000 for the Water Commission.

ENGINEERING AND CO-OPERATION*

By Dr. Ira N. Hollis

President, Worcester Polytechnic Institute, Worcester, Mass.

ONE can hardly speak to a group of engineers on any subject at this time without some reference to that which is present in the minds of all Americans, the war into which we have entered, perhaps the greatest struggle in all history. Under any circumstances, it is the greatest in the cause of freedom and democracy. It is truly a war for the union, in the same sense that our Civil War was a war for freedom and unity.

I have heard it called an engineers' war, but I prefer to put it in another way. It is a war in which engineering training or, at least, the kind of training that is given to all engineers and men in applied science, counts most.

I listened a few days ago to a Frenchman who had come to this country to ask help of Americans by means of certain specialized regiments behind the lines in France. He suggested the need of at least 60,000 men, without any military training, for service behind the fighting lines, and he described the war as an industrial enterprise, rather than the kind of thing that we have always thought of in discussing the war. The organization is essentially that of any great company for manufacture and transportation. This French officer spoke about the immediate necessity for engineers to make arrangements for transmission of power, for communications, for the continuous supply as the English and French surge forward into the country occupied by the Germans. To a limited extent, America has already begun to send specialized regiments to France for railroads, forests and mines.

In this sense, the was is an engineers' war, but in the larger sense it is everybody's war, as it involves the co-operation of every interest in the United States, from the infant to the old man. It is not to be won by the farmers, as some would have us think, or by the mechanics, or by the railroads, or by the soldiers. It is to be won by all of us.

When one speaks of war, the word "co-operation" comes into one's mind as a matter of course. That is the one element of success for an army. Devoted and willing co-operation in obeying orders for this great cause is bound to bring us to a glorious success. It seems to us at present as if co-operation were a new discovery and we hear so much of it that the world seems to have been heretofore poor in that spirit which enables men to work together to a common end. All civilization has been built up on co-operation from the time of the first lonely savage on this earth, through the long period of history that has brought us to the great American democracy. It has all been co-operation; that is what modern life is; so that when we talk of co-operation, we must not forget that civilization bears a direct proportion to the capacity of human beings to work together. In a representative government, that means always the rule of the majority.

There are two kinds of co-operation. The first perhaps is not co-operation at all. It is that kind where the great mass of a nation are more or less forced to work under a privileged class. We are in the habit of calling that autocracy, but it is, after all, the strongest kind of co-operation developed by a few men whose business and power it is to plan for a broad co-ordination of everything within national boundaries. I cannot believe that it is the best kind of government, although it does stimulate the kind of intense activity that we see now in Germany, and

*Abstracted from paper read before the Cleveland Engineering Society.

have seen for the past forty years. In the long run, however, men will get along better where there is a willing surrender of self to the needs of a great democracy like ours. I do not believe that democracy has yet had its fair test on this earth, and the comparison that demonstrates the efficiency of an autocratic empire in war as contrasted with a republic is not based upon a sufficient experience. So long as there is one autocracy left or one nation where a privileged class has the right to arrange the fate of every man and to plot in secret against races all over the earth, there will be no opportunity to determine what democracy can do for a new race. It can never have a fair test until the other kind of government is wiped off the face of the earth.

It is possible to have co-operation gone mad, and there are some examples of it in the United States, wherein the trade unions have banded together to limit the enterprise of the individual. Labor has even gone so far as to put on the Department of Labor Building in Washington, "Dedicated to Labor, Freedom, Justice and Humanity"; as if labor in the machine shops and on the railroads had any more right to freedom, justice and humanity than the rest of us. The motto applies to all of us. The only true co-operation I know of in this sense is the right or power to sacrifice one's self to the nation and to what might be called the social ideals of our country. That is the true liberty and the true equality referred to by the founders of this republic.

We must not forget, therefore, as engineers, when we begin to talk about co-operation, that it is nothing new. The topic for discussion ought rather to be how best to make it effective. What means should be adopted to bring it to something more than simply talk? How can it be applied to engineers in a special way, so that they can be more able to serve their country, or so that they may be more able to dedicate themselves to real service? Few engineers obtain great wealth unless they get out of engineering entirely and go into business or into manufacturing on a large scale. Consequently, I think of our profession as that which listens most willingly to the call of service. You have evidence of that in every state. The only profession I know of that is superior to it in the dedication of self is that of the school teacher or the ministry.

How can this word be made to mean something more to us as engineers than it has meant in the past? We ought not to think of it so much in terms of this war, although God knows that we need all the co-operation we can get to bring us to a successful end; but rather in terms of that brotherhood over the whole earth which will never permit another international difficulty to be settled by bloodshed.

I spent nineteen years in the American Navy, and during that time I do not recall a single American who wanted to see the United States at war for the purpose of testing out the ships and war machinery accumulated for national defence, and I never knew an officer who wanted to fire the guns in anger. I never knew a man in the Navy who did not look with horror upon the prospect of bloodshed and the misery that would have to be brought to every family by war. Consequently, my chief hope is that through co-operation of exactly the type that the engineer is capable of exhibiting, we may solve our difficulties in the future between nations without war and without bloodshed.

Engineers have always worked together more or less. We call this an age of specialization in connection with engineering, but what is specialization but co-operation? "Everyone to his trade" is taking co-operation for granted, and success is dependent upon it.

I want to say to you gentlemen to-night before I go into this subject that it is comparatively unimportant how co-operation is brought about amongst engineers, whether it comes through national engineering societies, through local engineering societies, through clubs, through colleges, or through the efforts of individuals in different parts of the country, so long as it is effective. If engineers can be made to recognize themselves as members of a great profession with exactly the same interest in serving the country, the incomplete efforts in the past, and various conferences and discussions to bring them all together, will seem but imperfect beginnings to us. The war has provided a psychologic moment when everything can be accomplished, because attention is called to our combined effort as the important thing toward the future. It will also be the most important thing in the readjustment of peace after this war is over, when every industry will have to get back to normal conditions.

A number of years ago I was president of the Boston Society of Civil Engineers, and we made a special effort to bring the representatives of all societies together. A committee was appointed to see what could be done about it. The result seemed at first disappointing, because the conditions worked more to strengthen the sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, but, after all, the main end was reached, because the Boston Society of Civil Engineers and the two sections mentioned have worked together like brothers in the profession ever since. Besides that, the Boston Society of Civil Engineers has since grown from 600 to 1,000.

Your own society here in Cleveland is a first rate example of what I mean by a local society of engineers. When you take part in the good government of the city of Cleveland, you are only fulfilling your obligations as citizens, and your engineering society not only has a right to take that part, but it has a duty to see that all that relates to sanitation, streets, transportation, and water supply are properly safeguarded. The only thing is to extend your society to the entire state, either by having it reach out to every part of the state or by affiliation with other engineering societies; so that you may have an Ohio State Engineering Society. Personally, I believe that the very best can be done by a union of a large number of local societies, just as I believe that the best government is based on local autonomy in sections of the country under one glorious flag.

There are several methods by which the engineers can be brought together into better co-operation:

(1) By means of a congress of all the engineering societies, to which a number of representatives shall be sent with power to commit the societies within limits.

(2) By means of a conference called from year to year for the purpose of recommending lines of common action to all societies.

(3) By means of a council beginning with a few societies and gradually extending itself into a nation-wide senate, with power to speak for the engineers along defined lines.

(4) By organizing in every state an engineering society composed of the smaller groups in the cities, having some national central congress to represent all the state societies.

The more the engineers study public questions, the more derelict we seem to have been in the past. As a matter of fact, our profession lacks in citizenship, because we have confined ourselves too much to technical problems. We have been too long content to occupy subordinate positions in the civic life of the nation.

What are the great public questions at the present time? The first relates to commercial standards. There is nothing more important in enabling our country, after this war is over, to hold its place in the modern world. A

committee of the four societies mentioned has already been formed to stimulate and encourage standardization. The Society of Automotive Engineers has done splendid work in this direction. It is hoped that the new standardization committee will include a large number of societies. It will certainly have representatives from the government as, for instance, the Bureau of Standards, the Army and the Navy. Its functions will relate to the acceptance, or promulgation of new standards. The standards themselves must necessarily grow out of commercial practice and must be established by the men who are most familiar with the commercial demands.

The second involves the great national question of coal saving by means of water power, by reduction of waste, and by increase of efficiency. Up to this time, our Congress has held back from development of water power on all public lands and has thereby rather encouraged the wasteful expenditure of petroleum and coal. All engineering societies are interested in this in one way or another.

The third great question is concerned with research on a great scale for peace and war. A large number of groups in colleges and in societies have been formed to conduct special kinds of research, but there is much overlapping, and this is a public question involving broad cooperation.

It would be possible to name a large number of activities undertaken in spasmodic fashion by individual societies, and yet which are common to all. If the newly organized council can develop contact with all of the engineers of the country and thus create a thoroughly democratic body, whose work extends to every field common to the engineering profession, it deserves zealous support. If it cannot, it should give place to some other body. Our country is peculiarly dependent upon the willing co-operation of individuals and of societies. In a nation like Germany with an autocratic government and a social caste which predominates over the individual, co-operative movements may be forced, but in our country, where every individual has complete freedom to develop himself, nothing but willing sacrifice of selfish motives will enable us to make of this country all that it deserves to be.

It has been suggested that the engineers as societies cannot go into politics. That is true, and no organization, whether it be engineering, legal or medical, ought to go into politics, so far as partisanship is involved. We cannot support a man because he is a Republican and we cannot support him because he is a strong advocate of the trade unions, but we can enter the legislative field in the interest of the entire country. Legislative matters connected with water power form a perfectly legitimate subject for activity among engineers and engineering societies. It may be said that the local societies can be more effective in relation to Congress or a Legislature than national societies. Furthermore, it is more natural for local societies to take part in the acts of State Legislatures and city councils; but there are a large number of interests in which the great national societies can act together and can be very influential in informing Congress on matters of importance to the country.

The estimates for the Board of Works, Windsor, Ont., this year, amount to $64,970. City engineer, M. E. Brian.

The Dominion Parliament has passed an estimate of $478,000 for dredging and maintenance of the St. Lawrence River ship channel.

Premier Charles Stewart, of Alberta, has announced that the government is making an effort to enlarge the market for Alberta coal, and is endeavoring to plan storage buildings at Winnipeg for lignite coal from that province, thus enlarging the marketing period to ten months in the year.

THE NIAGARA POWER SHORTAGE

A BRIEF review of the power situation in southwestern Ontario has just been issued by Arthur V. White, consulting engineer of the Commission of Conservation. He reports that the capital investment of the province of Ontario in connection with the systems which it operates, including the purchase price of the Ontario Power Company and of the Central Ontario System, is approximately $48,500,000. In addition, the municipalities have a total investment of over $21,000,000 in connection with their local distribution and operating systems. The Commission serves over 121,000 customers, of whom 4,000 are power consumers.

In August, 1917, the munition plants supplied with power by the municipalities and the Commission from the Niagara system were taking a total of over 78,000 h.p. with firm contracts amounting to 94,600 h.p. In the same month, the Ontario Power Co. was supplying some 44,600 h.p. for munitions and war materials. This makes a total demand upon the Hydro-Electric Power Commission and the Ontario Power Co. for munitions, of over 186,000 h.p. Of this, however, 30,000 to 35,000 h.p. may be considered as "off-peak" power, leaving a net requirement of some 150,000 to 155,000 h.p. The shortage on the Niagara system for munition plants supplied with power by the Commission and the municipalities alone, considered by themselves, may be placed at about 65,000 h.p. It is very interesting to note that, as a result of the campaign conducted through the daily press and by means of other agencies, the various municipalities have so adjusted consumption of electricity within their respective jurisdictions as to reduce the load "on peak" by from 20,000 to 30,000 h.p.

The following are some of the means by which this shortage may be supplied:—

(1) Increased utilization of steam power. This, at the present time, is out of the question as a means of dealing with the problem as a whole.

(2) Supplying temporarily, water from the unappropriated surplus, thus permitting the utilization of the excess capacity of the plants at Niagara.

(3) Curtailment of the power now used for street and other lighting, such, for example, as ornamental lighting.

(4) Utilizing the water of existing plants under more efficient conditions, such as will exist in connection with the new Chippawa project, which will operate under a head of 300 to 305 feet and provide about 200,000 h.p. It will, however, be approximately three years before relief can be obtained by such means.

The Hydro-Electric Power Commission of Ontario has recently installed equipment to supply an additional 50,000 h.p. from the plant of the Ontario Power Co.

(5) Limitation of the quantity of power at present being exported from Canada to the United States. As manufacturers of war munitions in the United States also are short of power, such limitation will require very careful consideration in its international aspects, so that full justice will be done to interests on both sides of the boundary.

The purchase of the Essex County Light and Power Company by the Hydro-Electric Power Commission has been completed. The properties of this company were owned and controlled by the Detroit-Edison Company, and situated in Essex. The plant comprises 55 miles of high voltage lines, 26,400 volts, and distribution systems in the municipalities of Amherstburg, Kingsville, Essex, Leamington, Harrow, Canard River and Cottam. Until power can be used the plant will be operated by steam, a contract for which has been arranged with the Canadian Salt Company. The purchase price was $226,000.

THE RESISTANCE OF A GROUP OF PILES*

By H. M. Westergaard
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THE distribution of pressure among a group of vertical piles carrying a vertical load is often determined by considering the total horizontal cross-section of the group as the cross-section of a beam under similar loading. For this special case such a solution is satisfactory; but when some of the piles are battered and the group is irregular, like that shown in Fig. 1, the solution based on beam theory would be seriously in error. Exact analysis of the group in the figure gives the separate pressures indicated on each pile. It is noted that the maximum pressure coming on any pile in the group comes on one of

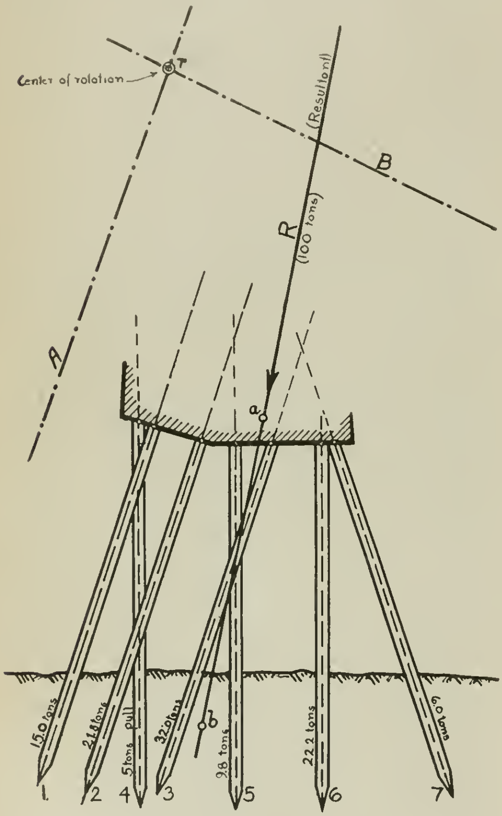

Fig. 1

the central piles, a result widely at variance with results of the solution mentioned above. (A solution of the general case is proposed by Max Buchwald. See Deutsche Bauzeitung, Betonbeilage 1913, 2, p. 188, and 1915, 1, p. 77. This solution is incorrect as it does not take the deformations of the piles into consideration.)

It is proposed in this paper to present a method of determining the distribution of pressure among any irregular group of piles such as that shown in Fig. 1.

*Paper read before the Bridge and Structural Section, Western Society of Engineers.

The piles are assumed to be arranged in planes parallel to the plane of the paper, and parallel to the resultant force, R. The displacements considered are parallel to this plane, and, in general, will be considered as infinitesimal. Each pile will be assumed to be hinged at its head and at some theoretical point near the lower end; thus, only axial loads will be considered as acting on the pile. The portion of the supported structure which rests immediately upon the piles will be called the "pier." It will be assumed to have the character of a solid mass, such that only small internal deformations will exist, when compared with the changes in length of the piles. The pier will be assumed to be supported by the piles only, both vertically and horizontally.

The pier and the piles taken together are assumed to constitute an elastic structure in which the displacement will, within certain limits, be proportional to the loads causing them. Such limits will in some cases proceed from the assumption that certain piles may not be designed to take tension. If, by applying the method which follows, any such pile is found to have tension the analysis is to be reapplied with this pile omitted, as though inactive in the structure.

The action of the structure under the load is defined when the motion of the pier is known. In the general case this motion may be characterized as a rotation of the pier through a certain angle about a certain centre of rotation. In special cases the displacement of the pier is a parallel motion. Such a motion may be considered as a rotation about a point at infinity. We may in all cases, therefore, speak of a rotation as characterizing the displacement. It will first be shown how the pile pressures depend on the rotation centre and rotation angle; then a lemma relating to certain qualities of reciprocity will be introduced. On this basis a method of dealing with any particular case will be developed. Finally, the resistance in general will be discussed, assuming a varying resultant.

To Find the Pile Pressures When Centre of Rotation and Angle of Rotation Are Given

The notation used to find the pile pressures when centre of rotation and angle of rotation are given is as follows:

r = centre of rotation.
ϕ = angle of rotation measured in radians.
p = distance from centre line of any pile to centre of rotation. p shall be considered positive if a shortening of the pile would increase ϕ, otherwise negative.
l = length of pile measured from the assumed hinge at the top, to the theoretical point of support (at which a hinge is assumed), near the lower end.
e = shortening of pile.
$E.A$ = modulus of elasticity times cross-section of pile.
P = total pressure on any pile.

1-2 in Fig. 2 is the original position of a pile, and 2-3 the motion of the top end due to the rotation of the pile head through the angle ϕ about r. 2-4 is the shortening e. Point 5 is the projection of the centre of rotation on the centre line of the pile. If point 5 is considered as attached to the pier it moves to the position 6. As the displacements are treated as infinitesimal quantities we may write: Distance 6-3 = 6-4, hence 2-4 = 5-6, or, the shortening of the pile is

$$e = p.\phi \qquad - \quad - \quad - \quad - \quad (1)$$

(= distance of centre line of pile from centre of rotation times angle of rotation.)

From formula (1) follows the expression for the corresponding pile pressure

$$P = p. \ (\phi EA/1) \qquad - \quad - \quad - \ (2)$$

Reciprocity of Lines of Resultant and Centres of Rotation

If the rusultant, R (Fig. 3), produces a rotation about a point r, then a resultant S passing through r will produce a rotation about some point s located on R. In other words, if R has its rotation centre on S then S has its rotation centre on R. This applies in general to the displacements of any line element attached to any elastic structure.

A proof of this theorem will now be presented. It follows closely one given by Ritter with his derivation of the fundamental qualities of the ellipse of elasticity.* It is based on the general theorem of reciprocity named after Maxwell and Betti,† which states in one form that the displacement along one path caused by a unit load along some other path is equal to the displacement along the second path due to a unit load along the first path. Applying this to the present case (Fig. 3) we have: The displacement of the point r in the direction S due to a unit load acting along R is equal to the displacement of the points on R in the direction R produced by a unit load acting along the line S. The displacement of r is zero when r is the centre of rotation, hence the displacements of the points on R in the direction of R produced by the force S are zero. Hence the centre of rotation s corresponding to a force along the line S is located on R, which was to be proved.

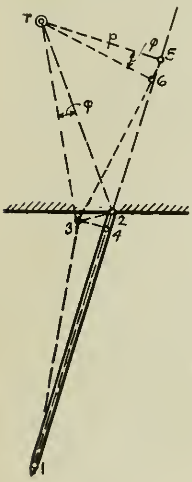

Fig. 2

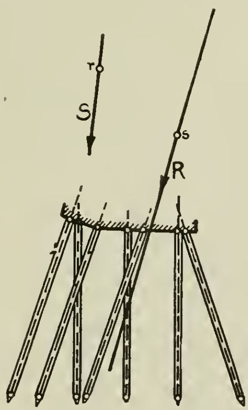

Fig. 3

To Find the Centre of Rotation When the Resultant Force is Given

The determination of the rotation centre is the first step in the treatment of any particular case of loading. Let R in Fig. 1 be the resultant force transmitted through the pier to the group of piles. r is the corresponding centre of rotation, which is to be determined. Now, assume temporarily that the pier rotates through a certain angle about the point a chosen anywhere on the resultant R. This rotation would produce certain deformations in the piles. The corresponding pressures on the piles may

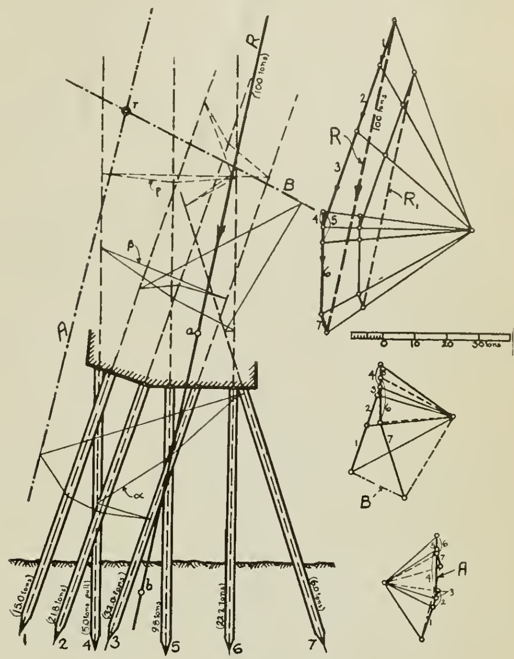

Fig. 4

be found by formula (2). These pressures are composed into the resultant A. By virtue of the above quality of reciprocity between lines of action and centres of rotation the centre of rotation r will be located somewhere on A. We will then choose another point b on R, and find in the same way its corresponding resultant B. The actual centre of rotation r is the point of intersection of A and B.

In Fig. 4 the auxiliary resultants A and B are found by drawing the funicular polygons α and β. The corresponding force polygons A and B are shown to the right in Fig. 4. The piles are in this case assumed to be of equal length, cross-section, and modulus of elasticity. Then, owing to formula 2, the pressures used in the force polygons A and B may be measured as proportional to (for instance, half of) the distances from the respective centres of rotation to the centre lines of the piles.

To Find the Pile Pressures When the Resultant Force and the Centre of Rotation are Known—Methods of Checking Results

Having determined the centre of rotation r it will not be difficult to find the distribution of pile pressures. Assuming arbitrarily some angle of rotation ϕ_1 about the centre of rotation r a set of corresponding pile pressures proportional to the real pressures may be found by formula 2. A force polygon gives the corresponding resultant R_1. In Fig. 4 the piles were assumed of equal length, cross-section, and modulus of elasticity. Accordingly, the pile pressures in the force polygon R_1 are taken as proportional

*W. Ritter: Graphische Statik, III., Ed. 1900, p. 260.

†Given in most texts on Mechanics of Structures. Announced in its first special form by Maxwell (1864), later expanded by Betti (1872) and Lord Rayleigh (1873). For references and for a general proof see A. E. H. Love, Mathematical Theory of Elasticity, 1906, p. 170.

to (half of) the distance from r to the centre lines of the piles. The force polygon for the real pile pressures is found in Fig. 4 by magnifying the force polygon R_1 in the ratio of R to R_1.

The results may be checked by the fact that R_1 found by the force polygon must have the same direction as the original resultant force R_1. A more complete check was

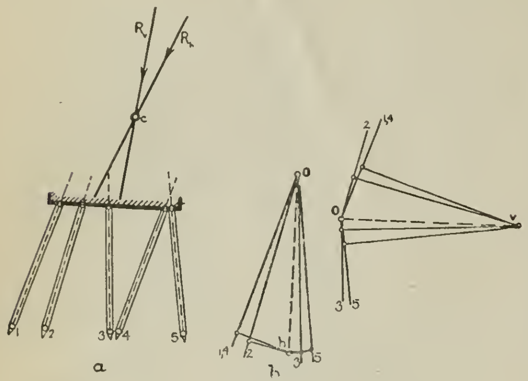

Fig. 5

obtained in Fig. 4 by drawing a funicular polygon ρ, corresponding to the force polygon R, and in this way the original line of action R was refound.

Special Cases: Parallel Motion; Forces Applied Forming a Couple; Centre of Elasticity

With special location of the force R, the lines A and B in Fig. 1 may become parallel. In that case the centre of rotation would be at infinity and the motion of the pier would be a parallel motion perpendicular to the lines A and B. The shortenings or elongations of the piles due to parallel motions of the pier may be found graphically by the method shown in Fig. 5 (a, b and c). Fig. 5a shows the group of piles and the pier under consideration. To find the effect of a unit horizontal motion of the pier lay out $\overline{\text{O-h}}$ = unity on a vertical line, as shown in Fig. 5b. Draw through O lines parallel to the piles 1, 2, 3, 4, 5 in Fig. 5a. A motion towards the left will shorten piles 1, 2 and 4, and elongate piles 3 and 5. The total shortenings and elongations of the piles are found as the distances in Fig. 5b from point h to the lines parallel to the piles. That this is correct will be seen by changing Fig. 2 in the following way: Move the rotation centre r to infinity in vertical direction, make 2-3 horizontal and equal to unity, then 2-4 will continue to represent the shortening of the pile. By turning triangle 2-3-4 90° clockwise we reproduce the part of Fig. 5b which corresponds to one pile.

Pile shortenings due to a unit vertical parallel motion downwards are found in the same way in Fig. 5c. O-v is a horizontal vector equal to unity. The pile shortenings are equal to the distances from the point v to the lines 1, 2—5 through point O parallel to the piles.

The shortenings of the piles determine the pressure on each pile by the usual formula (2). Each set of pile pressures may be composed into a resultant, for instance, by drawing a funicular polygon. In this way the resultants R_h and R_v in Fig. 5a were found; they correspond to the horizontal and vertical translations respectively. Translations in other directions than the horizontal and vertical may be treated by the same method. In all cases resultants passing through c will be found.

Another important special case is that in which the resultant load is a couple. This case will appear to be closely related to that of a parallel motion; in fact, the two cases are in some respects reciprocal. Assume that the resultant is a couple; this may be interpreted as the limiting case in which the resultant force is at infinity. Then it is possible to apply the method illustrated in Fig. 1 and Fig. 4. We assume that R in Fig. 1 moves out to infinity. The two auxiliary centres of rotation a and b may be chosen as the points at infinity in the vertical and horizontal directions, respectively. The corresponding rotations are the parallel motions in horizontal and vertical directions, respectively. Assume that the group of piles under consideration is that shown in Fig. 5. Then the lines of action A and B corresponding to the rotations about a and b will be the same as R_h and R_v, the lines of the resultants producing horizontal and vertical translations. Their point of intersection c is the rotation centre when the resultant is a couple. Instead of using the horizontal and vertical translations, any other two directions might have been introduced in determining c. The relation between the moment of the couple and the corresponding angle of rotation is found by first determining the pile pressures for a certain angle of rotation, using the usual formula (2), and then composing these pressures into a couple.

It is evident that the point c is of particular importance in defining the general elastic qualities of the structures. It is the point through which the resultant must pass in order that a parallel motion shall take place, and it is the centre of rotation when the resultant is a couple. Following the terminology used in Ritter's theory of the ellipse of elasticity it will be referred to as the centre of elasticity. It is conjugated to the line of infinity as in Fig. 1, point r is to R, a to A and b to B. It is also seen that the centre of elasticity is essential in defining the interrelation be-

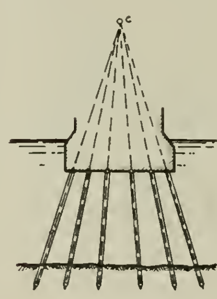

Fig. 6

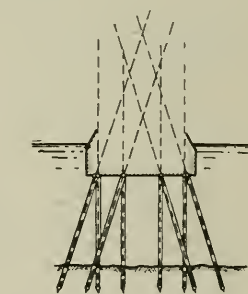

Fig. 7

tween the cases of parallel motion and that in which the resultant is a couple.

General Elastic Qualities of the Group of Piles

The elastic qualities of the group of piles as a whole may be described by the following characteristics:—

The centre of elasticity (c in Fig. 5a).

The resultant R_h corresponding to a unit horizontal translation (Fig. 5a).

The resultant R_v corresponding to a unit vertical translation.

The couple necessary to produce a unit rotation about the centre of elasticity.

It is worth noting that R_h and R_v must be known both in magnitude and direction. Owing to Maxwell's and Betti's theorem of reciprocity, they are interrelated in that

the vertical component of R_h is equal to the horizontal component of R_v.

The general state of elasticity of the group is defined by these data because any resulting load may be decomposed into components along R_h and R_v, and a couple. Each of these three component loads may be treated separately, as causing, respectively, a horizontal translation, a vertical translation, and a rotation about the centre of elasticity.

Reference is made to three general methods of treating such cases of elastic resistance:

First, the method of the ellipse of elasticity, developed by Ritter.* The centre of the ellipse is the centre of elasticity, and force and centre of rotation correspond as antipolar and anti-pole.

Secondly, the application of Land's stress circle† should be mentioned. This method gives information about the elastic displacements of the centre of elasticity due to resulting forces in varying direction. The method is convenient in graphical analysis.

Thirdly, attention is called to the use of a linear vector-equation (dyadics equation) in representing the relation between the displacement of the centre of elasticity and the magnitude and direction of the force applied.‡

Any of these three representations bring out the principal axes of the elastic resistance, that is, two directions perpendicular to one another, having the quality that forces in these directions produce motions of the centre of elasticity in their own direction. The second method, applying Land's circle, gives a convenient graphical determination of these principal axes.

Classification of the Method Applied

If there are more than three rows of piles in the group the structure is statically indeterminate. It is treated by determining certain displacement qualities, say, two co-ordinates of the centre of rotation, and the angle of rotation. In primarily determining displacements the method is contrasted with the great number of cases in which stresses in redundant members are the variables in the equations of elasticity, and it is classified with such methods as the slope-deflection method applying to frames.§ In our graphical treatment the two lines A and B in Fig. 1, intersecting one another in the centre of rotation correspond to two of the necessary elasticity equations, while the solving of a third elasticity equation is replaced by the graphical determination of the magnitude of the resultant (Fig. 4, force polygons at right-hand corner at top).

General Conclusions

The greater the distance between the centre of rotation and the centre line of a certain pile, the greater is the load transmitted to that pile. This explains that in Fig. 4 the second and the third pile from the left carry greater pressures than the first pile. In general, it is seen that when the piles are not all parallel the greatest pressures are likely to occur in other than the extreme piles.

Figs. 6 and 7 show two designs of pile groups supporting, for instance, a bridge pier. In Fig. 6 all pile centre lines intersect in one point c. A resultant load not passing through c cannot be resisted by the resultant of the pile pressures. Unless the pier or the piles are supported transversely such a resultant would cause an unrestrained rotation about c, and the pier would act as if it were hinged at c. The arrangement in Fig. 6 would not be adequate as an abutment support for a continuous arch system, neither would any arrangement in which the piles are approximately intersecting at one point.

Fig. 6 represents an extreme case. Now consider the design in Fig. 7. It is seen that a possible rotation about any point would be resisted by at least some of the pile pressures. In this respect the pile group in Fig. 7 possesses a superior rigidity compared with that in Fig. 6. In general, to obtain rigidity and strength with a limited number of piles in a limited space, two requirements must be satisfied: First, resistance against the various components of the resultant loads is to be secured by battering a proper number of piles. Secondly, to prevent turning of the pier, points of intersection of centre lines should be at proper distances from at least one other point of intersection of centre lines of piles, and, if possible, the resultant load should pass between these points of intersection.

*W. Ritter: Graphische Statik, for instance, Vol. III., Ed. 1900, pp. 259-264.

†Robert Land, Der Spannungskreis, etc., Zeitschrift des Vereines deutscher Ingenieure, 1895, pp. 1551-1554.

See also L. J. Johnson, The Determination of Unit Stresses in the General Case of Flexure, Association of Engineering Societies, Vol. 28, 1902, pp. 251-289.

‡See for instance: L. Silberstein, Vectorial Mechanics, 1913, p. 92.

§Wilson-Maney, University of Illinois, Eng. Exp. Station, Bulletin No. 80, 1915.

ICE DIVERSION, HYDRAULIC MODELS, AND HYDRAULIC SIMILARITY

In *The Canadian Engineer* for January 17th there appeared a paper on "Ice Diversion, Hydraulic Models, and Hydraulic Similarity," by B. F. Groat, M.Am.Soc. C.E. The following discussion of Mr. Groat's original paper appears in the Transactions of the American Society of Civil Engineers:—

J. Waldo Smith, M.Am.Soc.C.E., New York City: It does not seem that the point made by Mr. Groat as to the efficiency and value of small models in solving hydraulic problems can be emphasized too strongly. It is truly surprising how nearly the results indicated by his models were verified by subsequent actual experience. The results obtained on small models are usually to be considered as being indicative rather than absolute, and this is especially the case in the new fields of hydraulic construction where we have to deal with what may be called excessive head, quantity, or velocity. In such situations the search must be for a guiding experience which will tend to indicate all possible limitations as to structural dimensions, and as to the factors of flow, of velocity, and of turbulence in the passing water.

With these ends in view, a model was constructed in connection with the design of the spillway and channel of the Boonton Dam, at Boonton, N.J. The line of the spillway channel was at a very acute angle with the axis of the overfall section, so that when the water had passed into the channel, after a fall of 50 ft., its velocity would have been very high. Such a condition would have called for a high and massive retaining wall, in order to keep the waters within the channel section. This problem was solved by constructing a model and by studying the behavior of the water when passing over it. As a result of these studies, a steep chute was constructed at one end of the spillway section, so that the water passing down it would acquire a high velocity parallel with the axis of the overfall, and thus by its weight and volume cause the resultant between it and the volume of the overflowing water to coincide with the axis of the channel.

At the present time, the general plans of the new overflow dam on the Schoharie development of the Catskill water system are being studied, and there will be built a good sized model of the dam and spillway before decid'ng

on the various structural details involved. Here the dam is to be at right angles to the stream bed. The water will pass over its crest for a length of 1,300 ft., all on one side of the valley. The fall will vary from 160 ft. at one end, decreasing up the side of the valley to about 20 ft. The down-stream face of the dam is to be formed in large steps, from 10 to 20 ft. in height and from 10 to 18 ft. in width. The water will finally fall into a spillway channel along the toe of the dam, the bottom of the channel having a steep grade to the present stream bed. A high wing-wall will be built along the far side of the original stream bed, nearly at right angles to the dam and also at right angles to the axis of the spillway channel. It is expected that the model will give much information as to the action and behavior of the water and in determining many details as to the structural design, with particular reference to any features which may be needed in order to guide and control the direction of flow.

The author's reference to the skimming process recalls to the speaker's mind one of the best examples of this process which he has seen. At Omaha, Nebr., the very turbid Missouri River water was pumped into a settling reservoir, composed of a series of basins about 30 ft. deep. The water paused in these basins and then successively passed over long weirs separating the basins. The sediment settled quite rapidly, so that the thin skin passing over the last weir was, when seen, quite clear—for water of such character—and reasonably satisfactory for use without coagulation or filtration.

Robert Fletcher, M.Am.Soc.C.E., Hanover, N.H.: The author has made a very positive and questionable statement on the "Performance of Models" in the following words:

"His conclusion concerning this matter is that models perform in much the same way as the full-size prototype. In fact, there was nothing in the results of the experiments to indicate that they did not perform exactly as their prototypes. These statements apply equally to hydraulic models of all kinds, whether they be of machines, such as water-wheels and pumps; of structures, such as overflow dams, weirs, and spillways; of sections of an actual river or canal; or of ships."

The inexorable laws of Mechanics forbid any such sweeping general conclusions. William M. Torrance, M.Am.Soc.C.E., has made a convincing exposition of this question in an article entitled "Use of Models in Engineering Design" (Engineering News, December 18th, 1913), and has warned his readers against misconception of the value of such models in practical applications. Having made a model of a concrete water tank on a concrete trestle tower to a scale of 1 : 30 he showed that the model was proportionately stronger than its prototype of full size, inversely as the scale, or thirty times as strong. The apparently surprising strength and agility of diminutive creatures, like frogs, fleas, etc., in leaping power, was shown not to be remarkable, because the proportionate strength of their limbs, being as their cross-sections, are as the square of the linear scale of their size, though the weights are inversely as the cube of the scale; hence their relative muscular power is as the scale of their dimensions. Therefore, a frog or a flea can leap as far as a man can jump, because he has relatively more strength in proportion to his weight.

Commenting on this article, the writer added, among others, the following examples:

Passing from statical conditions to dynamical the following examples are to the point:

"Before the elevated railway was built in Boston the late Capt. J. V. Meigs made strenuous efforts to have his single-truss elevated railway adopted. The track or 'way' or truss was provided with two bearing rails for the horizontal wheels and two lower rails for the diagonal wheels of a unique form of truck, and the truss was supported on a single line of columns, as in the first New York elevated railway. This is fully described in Vol. VII., Transactions, Am.Soc.M.E., paper No. 189. An expensive working model was set up in a large upper room of a warehouse in East Cambridge, Mass., where the inventor demonstrated the 'successful working' of his scheme to visitors, as he did to the writer and a class of students in November, 1885.

The model engine weighed 275 lbs., the tender 80 lbs., with a model car six feet long. Steam was 'gotten up' quickly and the train developed an average speed of $10\frac{1}{2}$ ft. per second, passing curves of $6\frac{1}{4}$ ft. radius and mounting grades equivalent to 610 ft. per mile (adhesion increased by accumulator pressure on the horizontal truck wheels). On level track a speed of 22 ft. per second was made.

"This performance doubtless convinced the most skeptical; but on this occasion the spectators were reminded that the forces in action, especially the centrifugal reaction (not force, but the opposing effect of inertia as the body is incessantly pushed by the curving rail toward the centre) on the curves, would be vastly out of proportion to the scale, in the full-sized train. The model was made on a one-eighth scale, and, if W represents the weight and v the velocity of the model, this centrifugal reaction would be expressed by $\frac{W}{g} \times \frac{v^2}{r}$. Assuming a velocity in the same proportion, one-eighth of, say, 66 ft. per second (45 miles per hour) = $8\frac{1}{4}$ ft. per second, and radius r of curve in like ratio, then, since W of the large engine will be as the cube of the scale, we have the action of the actual engine measured by $\frac{(8)^3 W}{g} \times \frac{(8)^2 v}{8\,r} = 4{,}096\,\frac{W}{g} \times \frac{v^2}{r}$. To resist this the strength of track-frame, trusses, columns, etc., which depends upon the cross-sections, would be in the ratio of $(8)^2 = 64$ to 1 : and the disproportionate dynamic effect of the full-sized engine would be $4{,}096 \div 64 = 64$ times greater than any which the model could exert. The numerical measure of the larger effect would be, on a curve of $6\frac{1}{4} \times 8$ ft. radius: $4{,}096 \times \frac{275}{32} \times \frac{8\frac{1}{4}\ 8\frac{1}{4}}{6\frac{1}{4}} = 384{,}000$ lbs. This is 2.7 times the weight of the machine ($275 \times 8^2 = 140{,}800$ lbs.); but it will be noticed that the radius is quite short and the speed (66 ft. per second) for so sharp a curve is not permissible. Right here is where the uninstructed experimenter is deceived if he infers proportionate dynamical stability from the beautiful behavior of the model.

"A different case is that of an experimental model dam. In a discussion we usually consider only a unit of length, say, 1 ft. Assume a model 2 ft. high with any acceptable cross-section, to represent by a one-ninth scale a proposed dam 18 ft. high. Here relative statical effects depend upon the hydrostatic law that the [total] pressure varies as the square of the depth $\left(w \times h \times \frac{h}{2} = \frac{wh^2}{2} : w \times 9\,h \times \frac{9\,h}{2} = 81\,\frac{w\,h^2}{2}\right)$. But the similar cross-sections also vary as the square of the scale; and all pressures and resultants in the two cases hold the same relative position. Hence, this is a case where the full-sized dam really has stability proportionate to that of the model.

"This condition, however, is far from true when overflow occurs. For instance, assume 6 ins. gauge depth of flow over the model, which would represent 54 ins. over

the proposed crest. Now, the hydro-dynamic law of discharge over weirs is (the quantity) $Q = c\,l\,h^{\frac{3}{2}}$, in which c is a constant, l the length and h the gauge height above the crest; and $(9)^{\frac{3}{2}} = 27$. Here, then, the discharge over the full-sized dam would be 27 times that over the model; and, more than that, it has nine times as far to fall (really $9\frac{1}{2}$, from the centre of gravity of the overfall). The energy acquired, which measures its capacity for destruction, varies with the height of fall and is, therefore, $9 \times 27 = 243$ times that of the water discharged over the model dam.

"Considering this inexorable mechanical law, the designer may anticipate in some degree the tremendous impact against the backwater below, the scour on the bed of the channel, the 'kick-back' or reaction against the apron and toe of the dam, the vacuum effect upon the dam itself, etc.; but these would not be even faintly suggested by the behavior of the model and its 6-in. overflow."

It may be objected to this discussion that we have assumed 1 ft. in length, both for the actual dam and its model; whereas we should make the comparison by using only 1/9 ft. of the model; and that, therefore, gives only 27 to 1; or, the relative effects are as the $\frac{3}{2}$ power of the scale ratio; but that is just where we are deceived. It is true that the total effect of shock and destruction along a line only one-ninth as long in the model as in the dam is only as 1 to 27; but the destructive effect will not be confined to a proportionate length. The convenient unit of 1 cu. ft. of water and 1 lin. ft. in both cases is proper, because it is required to compare the energy, symbolized by Wh (of the model), with that of $W'\,h'$ of the real conditions; that is, Wh compared to $27\;W\;9\;h$; or, to state it otherwise, we are concerned here to compare the shock or destruction per foot or other equal length.

In a recent work, J. L. Van Ornum, M.Am.Soc.C.E., gives an interesting account of some elaborate experiments made by German engineers at the Experimenting Establishment in Berlin. These are right to the point in this discussion. The problem and plan of procedure are stated thus:

"Because of uncertainties with regard to the attainment of entire success in being able to definitely represent on a small-scale model all the conditions of a natural river and to be assured that the effects of artificial modifications in the streams are correctly indicated by corresponding changes of the model, it was decided that the first requirement was the true reproduction of a definite part of the natural Weser River, and then to compare the effects of flowing water upon it with the state of the river bed which had been produced by corresponding conditions. If this experimental verification of the correctness of the details of reduction in scale and choice of materials proved satisfactory, then it could be confidently assumed that experimental investigation of the effect of any proposed plan or detail of regulating works would show, on the model, the consequences that would result from the same construction of full size in the river itself. For this purpose a portion of the Weser, 1.6 km. in length * * * was chosen because of its availability in its definitely known characteristics both in its natural state and after works of improvement had been installed, the stability of its bed in showing similar conditions to exist at each recurring low-water stage, and because a more effective regulation of that stretch of river was desired.

"The condition of the facilities of the hydraulic laboratories caused the adoption of a scale of linear reduction of 1 to 100 for both horizontal and vertical dimensions. With regard to the character of material which should be used for the bed of the artificial stream, it was evident that a variation in size corresponding to that of the river itself is important; but the question of the suitable proportionate size was not so clear. It was said that apparently the ratio of volumetric reduction should be as 1 to 100, which would call for an average diameter of grain of about 1.7 mm. inasmuch as that of the river gravel was about 8 mm. However, after some investigations of the behavior of graded sand of various average sizes under the action of flowing water, * * * a river sand of an average diameter of about 1.2 mm. was chosen for the material of the model; this was, in later experiments, changed to 1 mm., or six-tenths the diameter which would keep the volumetric ratio of the particles the same as the linear ratio of reduction for the general dimensions of the model."

So, to begin with, a scale reduction was made, reducing the size of particles to be transported to only 0.6 of that required by the geometrical relations. Then the account goes on to state that four other requirements had to be satisfied, *viz.*:

"A correspondence in relative height of mean low water, mean high water and mean water levels, the range in the model, of course, being one one-hundredth that observed in the Weser; all these water levels are to have a similar corresponding relation with respect to the tops of the groynes; the depths and cross-sections of the three water levels must have a like relation to those of the natural river; and the discharge in the model is to have a constant ratio to that of the Weser at all three stages mentioned."

It was considered that the continued product of the slope, depth, and reciprocal of the diameter of the grain should have the same value in both the model and the river. For the river this product was 0.0000235 and for the model 0.021; but we learn that:

"Repeated experimental attempts to attain satisfactory results on the basis of that computed slope seem to have proved disappointing; at any rate, a slope of about one-tenth that value and a ratio of unit discharge of 1 : 40000 were experimentally found more satisfactory. Later, a surface slope of about 0.0015 and a corresponding discharge ratio of 1 : 50000 were found to produce a channel in the model still more nearly coincident with that of the river itself, especially for the higher stages."

So here, again, preliminary trials led to very considerable changes in the computed quantities. Then, in conducting experiments, the bank protection and controlling groynes in the model were made with "small sacks of shot," and "small pieces of slate, at slopes of 1 on 1." It would appear that the density and stability of such materials are almost as much out of proportion to the resisting qualities of the materials on the actual river as would be steel sheet-piling vs. brush mattresses and riprap. Erosion in the model was prevented or corrected by these bags of shot.

Although some interesting similarities in effects were found, on comparing the profiles and cross-sections of the model and the river, it was admitted that there is

"A lack of coincidence in details which suggests the conclusion that the system is not yet perfected. Such irregularities are found as differences in distribution of shallow and deep portions of the channel, the smaller depths in the reach shown by the model, the greater variability in the experimental depths, and especially the greater comparative depths in the concave banks. While the last-mentioned difference is not important with regard to the effect upon navigability, it is, nevertheless, one of the characteristics by which the question of the adequacy of experimental methods must be judged."

Following the statement quoted at the opening of this discussion, Mr. Groat makes the following further positive statement:

"In the case of hydraulic models, it can be shown that homologous velocities in models of different size must be proportional to the square roots of homologous linear dimensions. When the quantities of water have been properly adjusted to comply with this requisite, it may be said that the mechanical and hydraulic conditions in the two models are mechanically and hydraulically similar, just as the configurations of fluids and solids in the models are geometrically similar."

He then states that experimenters with water-wheels have overlooked these relations and conditions, and have failed to make proper tests of model wheels.

Now, the writer thinks that the instances cited by Mr. Torrance and himself plainly refute the idea of simple and always uniform inter-relations and analogies. It is shown that, in a model of a static structure, additional load must be supplied to the extent of the weight of the model multiplied by the scale ratio. (A model bridge made by the writer had to be loaded with 350 lbs. before the individual members were stressed in proportion to the homologous stresses in the bridge represented.)

In the single case of the model dam, as the pressure (load) itself varies as the square of the depth, the behavior of the model and its prototype are the same; but in all cases where dynamic effects are involved, we cannot usually make the model and its prototype comparable or analogous by simple adjustments or contrivances.

Referring now to the experiments conducted by Mr. Groat, the writer would not presume to criticize the procedure or question the validity of the conclusions, so far as they relate to the particular object sought, and strictly under the conditions stated. No doubt, as the German experimenters found, useful lessons may be learned from "model" performances, but only under very special and tractable conditions. We have seen how their protracted and painstaking endeavors resulted in admitted failure to gain the full result sought. For one thing, changes in the model or miniature could be made with ease; but similar modifications under actual conditions might involve great labor and expense or develop unexpected forbidding conditions which the mere model would not suggest. (Like a plan "on paper" vs. a procedure necessitated in face of the working conditions.)

Engineers familiar with our northern rivers, even those flowing from north to south, and thus under more favorable conditions for getting rid of ice in the spring, know too well some of the extreme conditions that defy calculation. Although pieces of paraffin in a small stream may simulate ice carried under ordinary conditions of moderately high water, they are essentially different from ice. They will not freeze together as will ice after a thaw followed by a "cold snap"; they would not readily be subjected to the great side pressure which drives ice laterally into side channels and high up on sleeping banks; they would not so easily simulate the great jams which fill the entire channel, pile up high above it, and cause an excessive rise of the river, leading to destruction of dams, mill buildings, etc.; neither would the miniature contrivance be likely to produce baffling conditions of back-water which vex the souls of those who operate power plants. The writer's observations and experience on a river like the Upper Connecticut is that artificial furrows or transverse ridges in the bed of the river would be speedily obliterated in whole or in part, either by erosion or filling up; and such aids as jetties for controlling the flow, as proposed, must needs be of expensive construction to be permanent, and may easily be overtopped by high floods. The following instances illustrating the above stated points are only a few among many which might be cited.

At Summer's Falls a rocky barrier extends so obliquely across the river that its length is nearly double the direct width of the river. About 50 years ago at this site there was a dam, a canal lock and approach canal for river boats, and a very large saw-mill running seven saws. A spring flood brought down ice which jammed and froze; a second flood increased the jam, piled the ice high on the dam and against the banks, and finally carried the mill down stream, and wrecked the dam and lock, which were never rebuilt. The writer has seen (Engineering News, November 14th, 1912, p. 893) an impressive picture of blocks of ice up to 4 ft. thick (a man standing beside one) wedged together over an extent of many acres, on one side of the Lower Yellowstone dam, in Montana, as the result of a high flood. This suggests in part the possibilities of destruction by a spring flood carrying ice.

At the Vernon dam and power house the spillway is 650 ft. long, and the fall, without flash-boards, is 32 ft. The river just below widens to 1,200 ft., but below that is a short curved narrows, about 400 ft. wide. Yet the engineer reports that in a high flood the water below the dam has risen to within 0.8 ft. of the crest, so as to make it for a time practically a submerged dam. How could any model dam and section of this bay and gorge, extending actually a mile on the concave, have suggested this condition of back-water?

When we consider the demonstrated fact that the transporting power of a stream varies as the sixth power of the velocity; that the energy of the flowing water varies as the cube of the velocity; and know that, by geometrical necessity, any model on a reduced scale lacks weight and stability in itself to test its full capacity, under diminutive conditions, we are obliged to object to the quoted all-inclusive claim for the validity of model studies and experiment, especially where hydro-dynamic operations are involved.

A. F. Parker, M.Am.Soc.C.E.: The writer has been actively interested in the problem of canal intakes and keeping them clear. This paper mentions only the matter of ice and floating materials, and in large streams, presumably of not very great fall. Under conditions of ice flowing in such large rivers, and with only moderate velocity, the sub-diversion channels described may produce very good results; but, in smaller streams, of heavy fall, such as are usually found in mountainous districts, it is not so evident that the method presented would produce the results sought. In mountain streams it is usually necessary to build a diversion dam at each intake. Sometimes such dams may be permanent, and in other cases movable dams are necessary in order to pass the annual spring floods. In the case of a permanent dam, the basin back of it always fills up with silt, sand, and sometimes heavier drift materials, so that in time there is only a limited space of any considerable depth at the intake. Movable dams are erected only at low-water stages, and, when removed to pass the spring floods, the current sweeps the deposits accumulated in the basin cleanly away. Thus the action resulting from the use of either form of dam would evidently preclude the use of sub-diversion channels.

In such cases—and such conditions obtain almost everywhere in mountainous localities—it is always very difficult to keep intakes clear of ice. The main reliance must be placed on drawing the water from the greatest depth possible below the surface. The still water above the dam holds the ice flow, but sometimes the mush ice reaches nearly the full depth of the water. Usually, a large gang of men is required to keep the intake clear, and it is impossible to prevent considerable quantities of ice from entering it.

In streams of the kind mentioned, however, the ice problem is not the only one involved in intakes, for it is equally difficult to contend with sand, gravel, and floating and submerged driftwood. During high water driftwood lodges against trash racks, as commonly placed, finer materials are then caught, and, with sand and silt, often make an almost watertight dam; sometimes it is as difficult to keep such racks clear, as when there are ice formations. Sand and gravel, washing into intakes and thence down the canal or pipe line, cause much damage to waterwheels, or they clog the canal and are not easily prevented. It is evident that sub-diversion channels are likely to be easily filled in by the river drift in times of high water, even in large, slowly moving streams; it is absolutely sure that the swiftly flowing streams common to the mountains would either fill them up or that they would serve to divert the sand and gravel—carried in great quantities by the torrential flows—into the intake; a condition it is desirable to avoid.

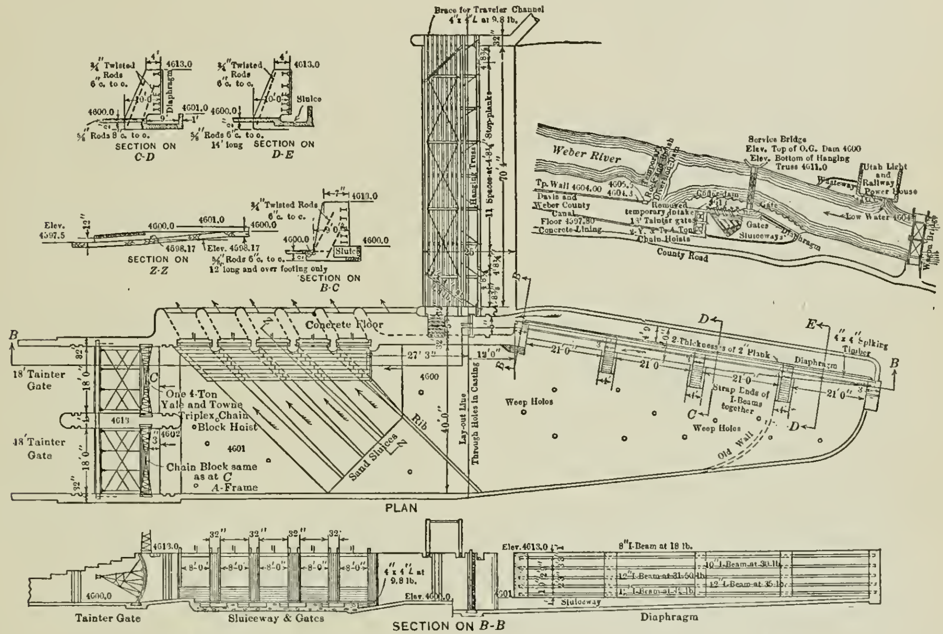

Fig. I—Main Canal Headworks of the Davis and Weber Counties Canal Company.

Perhaps it is unfair to discuss conditions differing so much from those assumed in the paper, as do the usual mountain streams, but the excuse is in the great interest and importance of the matter under all conditions. The writer submits plans (Fig. 1) showing an intake designed for an irrigation and power canal, where it was very difficult to deal with the ice in winter and the floating drift, sand, and gravel in summer. This intake was not built just as shown on the plans, and does not now give the best results. Had it been built as designed, it would surely have done the work in the best possible manner.

The plans show a movable dam across the stream, operated from a service bridge above it. In place of the usual trash rack, there is a vertical diaphragm of wood fastened to steel beams extending between undercut concrete piers and reaching in a straight line up and down stream and nearly parallel to it. This diaphragm is set above the middle of a concrete channel, with side-walls flush with the bottom of the river. The water is discharged below the dam, the flow through the concrete channel being controlled by a wooden gate. The diaphragm wards off all floating materials, and the space under it allows the water to pass to the intake. The channel or trough of concrete catches all sand and gravel washed down by the current, and the rush of the current of water through it removes all such material and prevents clogging; the channel has been given a heavy fall in order to accomplish this.

Below the diaphragm, and some distance away, there are two Tainter gates, each 18 ft. wide and 13 ft. high. Between the gates and the diaphragm, and on the river side, there are five wooden gates which serve as relief gates for the pool of water that the Tainter gates may be made to form. In the bottom, and leading to these five gates, there are some channels extending diagonally across and below the floor of the intake, and these catch and remove the sand which passes the diaphragm channel; the pool above the Tainter gates acts in some degree as a settling basin. The five wooden gates serve only to close the side of the channel and provide an overflow, but are arranged so as to operate the sand trap, being left up a short distance when there is water enough to waste, or are raised occasionally for flushing out the sand.

The arrangements to care for all conditions of flood or frost, and to remove the sand and gravel entering the intake are complete, and, provided there is sufficient fall to the location, cannot fail to do good work. The arrangement would need modification where the fall is light, but the general idea could be preserved. From the plans the design may be easily understood. It it not reasonable to regard a deflecting diaphragm, as shown here, with a subsurface intake entry, as promising better results under all conditions, and more logical to adopt in place of the usual rack so easily clogged either by trash or ice?

PIG IRON AND STEEL

The production of pig iron in blast furnaces during 1917 was supplemented by a small production of high grade low phosphorus pig iron in electric furnaces made from shell turnings and other steel scrap, according to preliminary returns of Mr. John McLeish, B.A., Chief of Division of Mineral Resources and Statistics, Ottawa. The total production from both sources (not including the output of spiegeleisen, or other ferro-alloys) was approximately 1,171,789 short tons (1,046,240 gross), final returns not yet having been received from all manufacturers of electric pig iron. Of the total, 1,156,789 tons were produced in blast furnaces and the balance in electric furnaces. In 1916 the production all made in blast furnaces was 1,169,257 short tons (1,043,979 long tons).

The small increase in pig iron production in 1917 was therefore due entirely to the electric furnace production, there having been an actual falling off in the blast furnace output.

The production in Nova Scotia in 1917 was 472,147 tons as against 470,055 tons in 1916. InOntario the production by blast furnaces in 1917 was 691,632 tons as against 699,202 tons in 1916.

Production by Grades

By grades the 1917 production included: Basic, 14,092 tons; Bessemer, 961,656 tons; foundry and malleable, etc., 181,041 tons; electric furnace pig (subject to revision), 15,000 tons. The 1916 production included: Basic, 953,627 tons; Bessemer, 31,388 tons; foundry and malleable, etc., 184,242 tons.

The blast furnace plants operated were the same as in the previous year—viz., the Dominion Iron and Steel Company at Sydney, N.S., the Nova Scotia Steel and Coal Company, at North Sydney; the Standard Iron Company at Deseronto, Ont., the Steel Company of Canada, at Hamilton, Ont., the Canadian Furnace Company, at Port Colborne, Ont., and the Algoma Steel Corporation at Sault Ste. Marie, Ont.

Pig iron was made in electric furnaces by: The Canada Cement Company, Ltd., Montreal; Frazer, Brace and Company, Ltd., Shawinigan Falls, Que.; British Forgings, Limited, Toronto, Ont.; Electro Foundries, Limited, Orillia, Ont.; and Turnbull Electro Metals, Limited, St. Catharines, Ont.

The total production in electric furnaces of pig iron ferro-alloys and steel ingots and castings was in 1917 about 99,000 short tons.

The production of ferro-alloys in Canada in 1917, chiefly ferro-silicon but including also spiegeleisen, ferro-molybdenum and ferro-phosphorus, all with the exception of the spiegeleisen being made in electric furnaces, reached a total of 40,329 tons valued at $3,471,934, as against a total in 1916 of 28,628 tons valued at $1,777,615.

Exports of Pig Iron

The exports during 1917 of pig iron were 12,081 tons, valued at $423,814 or an average of $35.08 per ton and of ferro-alloys 33,212 tons, valued at $2,616,924, or an average of $78.79 per ton.

The imports during 1917 included 82,758 tons of pig iron, valued at $2,744,055, or an average of $33.16 per ton; 632 tons of charcoal pig iron, valued at $19,447, or an average of $30.77 per ton; and 12,828 tons of ferro-alloys, valued at $2,029,990, or an average of $158.25 per ton, making a total import of pig iron and ferro-alloys of 96,218 tons, valued at $4,793,492. The United States trade records show exports to Canada during the 11 months ended November, 1917, of pig iron and ferro-alloys amounting to 130,087 gross tons (145,697 short tons), valued at $5,170,005, a figure considerably higher than the Canadian record.

Production of Steel

The estimated production of steel ingots and direct steel castings in 1917, final returns for all operations not yet having been received, was 1,736,514 short tons (1,550,459 gross tons) of which 1,690,170 tons were ingots and 46,344 tons direct steel castings.

The total production in 1916 was 1,428,249 tons, compared with which the 1917 production shows an increase of 308,265 tons, or 21.6 per cent.

The total production of electric steel in 1917 was probably not less than 50,000 tons, as against 19,639 tons in 1916 and 5,625 tons in 1915.

The exports of steel ingots, or billets, ingots and blooms, during the nine months ended December (such exports not being separately classified previous to April, 1917) were 41,558 tons, valued at $1,831,917. The recorded imports of iron and steel ingots and billets during the year was 20,429 tons, valued at $1,378,576. This item is also much lower than the United States trade record which shows exports to Canada during 11 months ended December, of 143,209 gross tons (160,394 short tons), of billets, ingots and blooms of steel, valued at $11,418,033.

STEEL SHIPBUILDING PLANT IN NOVA SCOTIA

The shipbuilding commission appointed in May, 1917, by the Nova Scotia government to investigate the possibilities for the shipbuilding industry in that province has made its report. The conclusion arrived at is that the encouragement of the steel shipbuilding industry and the measures to be taken for its development and growth is a matter primarily and essentially for the Dominion government. The report reads in part:—

"Many obvious difficulties will surround a permanent steel shipbuilding industry, but these will be less on the Atlantic than in any other part of Canada. Nova Scotia is rich in raw materials, can easily be equipped to furnish fabricated parts and offers a choice of more than one excellent location for a shipyard. The workmen of the province, who have shown such well tested skill in building wooden ships, can, we are confident, also build ships of steel. This, if proof were needed, has been demonstrated at New Glasgow, where, under the direction of Colonel Thomas Cantley, the Nova Scotia Steel and Coal Company, Limited, has completed and placed in commission one fine vessel, will soon be ready to launch a second and larger one, and a third of the same class is well under way.

NOVA SCOTIA STEEL AND COAL COMPANY

At the annual meeting of the Nova Scotia Steel and Coal Co., Ltd., held recently in New Glasgow, President Frank H. Crockard said:—

"At the blast furnace, open hearth furnace and rolling mill, we have amply demonstrated that the material possessed by the company can be satisfactorily converted into steel products of a superior grade. The manufacture of steel in Cape Breton has virtually just emerged from the pioneer period, and compared with other important iron and steel centres, it may be truly said to be in its infancy.

"As in all pioneer work, there were many problems which had to be satisfactorily solved and to-day it may be stated that as a result of these efforts there are no fundamentally serious metallurgical features which will interfere with quantity production. The development of wider markets will come with further diversification of the finished products, which necessarily must be produced by plants possessing all of the economic features characterizing modern mills. In forwarding such plans it would seem desirable to await the re-establishment of normal conditions."

The character of the products was very substantially changed during the last half of the year 1917. The ordinary commercial products constituted nearly 50 per cent. of the market value, compared with 15 per cent. during the preceding year. This was due to cancellation of contracts covering shell forgings. The company was compelled to adjust itself as quickly as possible to this radically altered condition, and in so doing, found it expedient to intensify the plate mill production. Owing to the large reserves on hand and due to unsatisfactory market and shipping conditions prevailing in 1917, it was found necessary to mine only about one-third of the furnace requirements during the year.

President Crockard quoted from a report received from mining engineer Edwin C. Eckel, in which Mr. Eckel refers to the Nova Scotia Steel and Coal Company's ore properties as representing perhaps the most important single iron ore holding in the world, in which, Mr. Eckel says, the coal properties are second only to the ore holdings in tonnage and value. "At the present rate of use," says Mr. Eckel, "the ore and coal would each last for over a thousand years, and at any probable future rate of use they will probably last for several hundred years. Putting the matter on a competitive basis, the Nova Scotia Steel and Coal Company will in all probability be mining iron ore at Wabana for a hundred years after the Lake Superior ore beds have been exhausted."

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Principal Contents of this Issue

"EMERGENCY" DEVELOPMENT AT NIAGARA

ON another page of this issue, W. W. Young, a consulting engineer of New York City, outlines one of a number of schemes that have been suggested for emergency development of Niagara Falls. Mr. Young's scheme is no doubt quite feasible, provided that the two governments are prepared to ignore the scenic factor for some years to come. But, despite all the arguments in favor of discouraging tourist travel at present, we doubt exceedingly whether any measure could be passed through the House of Commons at Ottawa, or through the House of Representatives at Washington, which would mean the total elimination of any part of Niagara Falls,—even temporarily.

The only possible argument in favor of an emergency measure of such far-reaching consequences as that proposed by Mr. Young, is the saving in time. The power-house, penstocks, etc., for the emergency scheme would no doubt cost quite as much, in proportion to the power secured, as would those for a permanent scheme. The great question, therefore, is how much time would be saved by such an emergency development in comparison with a plan of permanent development which would preserve the beauty of the Falls and at the same time take advantage of nearly the whole head between the two lakes? Mr. Young suggests priority orders to facilitate the manufacture of the machinery, but would it be physically possible to get the necessary machinery built—under present conditions—for two or three years? And by that time the Ontario Hydro-Electric Power Commission will be in shape to supply 300,000 h.p. from its new plant at Queenston and that should satisfy much of the power shortage until the completion of New York State's scheme for permanent development under high head. Moreover, in connection with any emergency development of Niagara, there would no doubt be construction difficulties which might take no short period to overcome, although, given time and money, they could unquestionably be conquered.

The unwatering of the American channel would probably be the easiest part of Mr. Young's scheme. The hasty construction of intakes along the American cliff might not be so easy if ice trouble were to be obviated. For the safe operation of the emergency plant in winter, the removable low dam at the crest of the American Falls presents difficulties of design that would take time to overcome. But the American side of Mr. Young's scheme is easy of rapid accomplishment compared with the Canadian side. Mr. Young has rendered a national service—both to the United States and to Canada—in directing public attention once more to the urgency of the power problem at Niagara and its importance in winning the war. That more activity should be shown in the development of Niagara—particularly on the American side of the border—cannot be gainsaid, but it is a matter for very careful engineering deliberation as to whether such development should follow "emergency" or permanent plans.

CONSERVING OUR WATER POWERS

NON-DEVELOPMENT of our fuel resources may in some sense be considered as conservation, because posterity benefits. In other words, it is conservation of our fixed capital. No such reason, however, exists in the case of our water powers, which renew themselves continuously and partake more of the nature of revenue producers, which revenue being lost from year to year through non-use, is lost forever.

In considering the development of many of our natural resources, we are prone to reason from the point of view of private capital investing in a business from which stock profits are expected. Considered as a national asset and apart from private ownerships, a wider view is necessary for that development which under existing conditions might not yield a stock profit, yet would if developed from the larger point of view yield a living for many; and in addition, even though no profits were made, money would be kept in the country instead of being exported, and immigration would take advantage of the increased labor market.

It is, therefore, incontestable that from a national standpoint our power should be developed, even although no cash dividend results. This involves retention in the hands of the government of the ownership of our water powers for development by the government; or if in private hands, under such regulations as will permit their resumption by the State under fair conditions which will not preclude the utilization of such private capital as may be obtainable.

Canada has a superabundance of water powers for all present needs, but in view of the increasing demand for power for electro-chemical and electro-metallurgical processes, it becomes pertinent to inquire as to whether we are utilizing our resources in the wisest possible way.

First consideration should be given to the question as to the population which can be supplied with the necessary power, both now and in the future, for ordinary manufacturing purposes. In other words, conservation and increase of population. Secondary to this is the development of bulk production of materials from this power

through the establishment of electro-chemical, metallurgical or other industries which, while demanding large amounts of power, support but few people. In other words, a policy of hand-picking our powers should be adopted by the federal and provincial governments, tending to conserve for the thickly populated parts of the Dominion such powers as are necessary for their common uses, and permitting the development for electro-chemical and electro-metallurgical processes only of those which are more remote from centres and therefore less valuable as supporters of population.

This is not to say that no power should be developed in manufacturing districts except for small manufacturing purposes, for it will frequently happen that a large and expensive power can only be developed in a manufacturing district if a large load be obtained which is sufficient to pay the bond interest from the start; but in this case it should be clearly understood that the electro-chemical user has only the right of use at cheap rates until the demands of the community require his power, which would then be salable at much higher rates for the greater good of the community as a whole. Neither are the above references pertinent when applied to such electro-chemical and metallurgical industries as can utilize off-peak power, provided again, of course, that these do not interfere with the overtime needs of the ordinary manufacturing plant. Furthermore, when only a limited amount of power is available, true conservation does not consist in so reducing the cost that it can be wasted, with a final result that industries for which such power is essential are robbed by those which under true conservation would utilize other agencies less valuable in that particular district.

The above is a mere academic discussion of obvious things as they ought to be, from which the very practical question arises as to how such matters can be adjusted and kept adjusted under a well-understood and accepted doctrine of conservation.

Some of our powers to-day are under the jurisdiction of the Dominion Government, but most of them are under the jurisdiction of the provinces. No true conservation in a national sense is possible except by the co-operation of provinces and Dominion. It is suggested, therefore, that some body,—call it "Ministry," "Department," "Commission" or by any other name,—should be constituted whose administration of our powers would be accepted by all governments under a general policy agreed upon, the results being logical development and the elimination of present patchwork methods.

Reference has been made to fuel resources as distinguished from water power resources. While in detail the doctrines applicable to these resources are different, the ultimate result expected from both is production of energy. Wide districts of Canada are bare of fuel but abundantly supplied with water power; others are without water power but are well supplied with fuel; therefore it is suggested that whatever steps are taken by the government in connection with our water powers, should carry with it the conservation and development of our fuel resources. In other words, whatever central body is constituted should deal with the energy problem of the country as a whole, and its jurisdiction should extend not only to water powers but to fuel resources, which are complementary thereto. It is only by such a method that the best use of our water powers can be determined.

The Quebec Railway, Light, Heat and Power Company is negotiating with several concerns in regard to the location of factories at or near Quebec City. The company has upwards of 20,000 h.p., which it can readily develop at short notice, and is looking for a market for it.

PERSONALS

J. W. Adams, city engineeer of Chatham, Ont., has resigned.

Lieut. Alex. Ross Robertson, of Toronto, has been wounded. He graduated in 1909 from S.P.S., Toronto.

R. C. Harris, commissioner of works, Toronto, has been appointed a member of the national committee to investigate the peat industry for the province of Ontario.

Lieut.-Col. William G. MacKendrick, D.S.O., who has just returned from France, will address the Engineers' Club of Toronto this evening on his experiences as director of road-building for the Fifth British Army.

Henry J. Fuller, vice-president of Fairbanks, Morse & Company, and president of the Canadian Fairbanks-Morse Company, Limited, has been elected a director of the Liberty National Bank of New York City.

F. C. Lane, O.L.S., has been appointed town engineer of Sudbury, Ont. He will have entire charge of the road, street and bridge departments and will also do all necessary engineering for the fire, water and light committee.

Norman Holland, F.S.C., will give an illustrated lecture this evening before the Montreal Branch of the Canadian Society of Civil Engineers, on "Modern Varnish Making." As a chemist and manufacturer, Mr. Holland will speak with authority in regard to wood and metal protective coatings.

W. Chase Thomson, consulting engineer, Montreal, will address the Montreal Branch of the Canadian Society of Civil Engineers this evening, on the "Kettle Rapids Bridge," giving the reasons for his adoption of the unusual design (a thousand feet continuous girder in three spans) and describing the construction methods used and difficulties successfully overcome in the erection.

Robert A. Ross, E.E., consulting engineer, Montreal, has been appointed by the Quebec provincial government as one of the five members of the new city commission that is to govern Montreal. Mr. Ross has not yet announced whether he is prepared to accept the appointmeent. He is a member of the Advisory Council for Scientific and Industrial Research, vice-president of the Canadian Society of Civil Engineers, and consulting engineer to the Hydro-Electric Power Commission of Ontario and to a number of municipalities and private companies.

OBITUARIES

Edgar M. McDougall, son of the late John McDougall, founder of the Caledonia Iron Works, died on April 4th at Los Angeles, Cal., where he had gone some time ago for his health. He was a graduate of the Royal Military College, Kingston. At the time of his death he was president of the Canada Iron Foundries, Limited, successors to the Canada Iron Corporation.

John B. Brophy, C.E., of Ottawa, who has been connected with the engineering staff of the Cornwall Canal for the past seven months, passed away on March 31st, following a stroke of paralysis. A couple of weeks previously Mr. Brophy had been taken ill with pneumonia, but appeared to be well on the road to recovery when he was stricken. He was in his 73rd year. Two daughters survive him. Mr. Brophy's only son, Lieut. "Don" Brophy, a well-known athlete, lost his life a short time ago while with the Royal Flying Corps.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

ENGINEERING PRESTIGE

Relation of Engineering Societies to the Community and to Their Members—Survey of What Is Being and Can Be Done to Improve the Welfare and National Status of Engineers

By R. O. WYNNE-ROBERTS
Consulting Engineer, Toronto

IT IS EVIDENT by the action taken by the Engineering Institute of Canada to adopt its present name and to revise its constitution and by-laws, and also by the unrest, not only in Canada but also in other countries, that the question which we have to consider is one which is occupying the attention of engineers generally.

In one form or another, this subject is discussed in addresses, debates and technical journals, for it vitally concerns the profession and is of importance to the public. For reasons which are more or less obvious, engineers do not occupy the status in public estimation to which they are entitled. The Engineering News-Record, of New York, recently referred to an advertisement which appeared in a Dallas, Texas, daily paper, which read: "Wanted at once, forty civil engineers, handymen, cooks, dishwashers and other high-class positions open." We may, of course, dismiss this as a humorous or ludicrous announcement, but it indicates in an ironical manner the estimation in which engineers are held by some people. We, of course, know that the profession is held in esteem by the thoughtful public, but the appreciation generally is not what it should be.

Clemens Herschel, the ex-president of the American Society of Civil Engineers, expressed the opinion that a large part of the lack of recognition was due to the fact that some of the expenditures on public works are made footballs of politics.

The subject of how to increase the prestige and influence of the branch may be considered from two main viewpoints; namely, the relation of the branch to the community, and the relation of the branch to the members. These again may be subdivided under different heads, because the subject covers such a wide field of consideration.

Relation of the Branch to the Community

W. L. Hichens, one of the foremost authorities in Britain in connection with the ship-building and engineering industries, stated in his Watts Anniversary Lecture for 1918, delivered at Greenock on January 18th, 1918, that "no man can serve two masters. He cannot serve himself and the community. He can only serve himself by serving the community."

Dr. J. A. L. Waddell, speaking before the Engineers' Society of Western Pennsylvania on February 29th, 1916, said, "It may be stated, without fear of contradiction, that the status of engineering can be improved mainly in one way; namely, by increasing its usefulness to humanity."

The war has produced a great change in the opinions of men and in their conception of citizenship, and possibly changes revolutionary in character and international in magnitude may take place in the early future. This may be postulated by the steps taken to consider questions involving national schemes of reconstruction of social and commercial organizations in Europe and in North America. Statesmen appear to be imbued with the great importance of this subject, and Royal Commissions have already reported in terms which are deemed to be so drastic and unusual that former conceptions of the relations between capital and labor and between the employer and employed have received a severe jolt.

Furthermore, the usefulness of engineers in these matters is being more fully apprehended, inasmuch as it is contended that as it was through their agency that social, commercial and political conditions of almost every country were transformed during the last century. They must play an important part in the affairs of the country to reconstruct the fabric which has been shaken to its very foundation by the war, and to assume their share of the responsibility of adjusting personal, commercial and national affairs. It is manifest that individual engineers can do much in this direction, but their representative organizations can do more, and the more comprehensive the membership and the more united the forces, the greater will be the possibility of promoting the prestige and influence of the branch.

These qualities, however, are not developed in the community without an earnest effort to serve and guide the people and to cultivate a healthy, vigorous and pronounced public opinion.

The shock and stress of the war have introduced many new problems; they have polarized into action many

NOTE.—Last summer the executive committee of the Toronto Branch of the Engineering Institute of Canada, appointed a sub-committee "to study means of increasing the prestige and influence of the branch." The sub-committee consisted of R. O. Wynne-Roberts, chairman and secretary, E. L. Cousins, H. E. T. Haultain, J. G. G. Kerry and W. Storrie. After considerable study by these engineers, and much correspondence, the chairman has prepared a very detailed and comprehensive report of the committee's research work. This report was written with the Toronto Branch troubles more particularly in mind, but most of its statements are applicable to all branches throughout Canada and to all engineering societies, so the report is of general interest. Instead of abstracting it, we are printing it herewith in full at the special request of the Toronto Branch executive. The executive request each member to read this report carefully so as to be able to discuss it fully at a meeting which will be called at an early date. The committee's shorter official report will be determined largely by the discussion thus aroused.—EDITOR.

schemes which were previously of more or less academic interest to us; they are compelling us to consider our ways and means and how to rehabilitate the social, commercial and political affairs, and they undoubtedly are driving forces to which we have to yield. The war is a war of engineers, and reconstruction must in a large part be the work of the engineer. Premier Asquith in August, 1917, said in the House of Commons that "no one who has any imagination can possibly be blind to the fact that the war, with all the enormous upheaval of political, social and industrial conditions which it involves, must in many ways—and ought to if we are a rational and practical people—suggest to us new problems or possibly modifications in the solution of the old ones."

It is somewhat remarkable that engineers as a profession have in recent years gradually come to acknowledge that their organizations have a great deal more to do beyond facilitating the acquirement and interchange of professional knowledge. The new by-laws of the parent Institute define that one of its objects is to enhance the usefulness of the profession to the public.

A committee appointed by the American Society of Civil engineers, when reporting on April 17th, 1917, stated that "engineers should realize and accept their duties as citizens of the community in which they live"; and further, they should exert "influence in the legislation of the State and the administration of its affairs wherever engineering principles or practices are involved." Local sections (branches) should volunteer judicious and carefully considered advice on public matters involving "engineering questions."

Dr. G. F. Swain, in his presidential address to the American Society of Civil Engineers' meeting at Ottawa in 1913, made the following observations: "The engineer is primarily a member of the social body. Its problems are his problems; he cannot avoid the responsibility of taking a share in their solution. Social problems are the outcome of the work of the engineer, who, as the advance agent of civilization, has been the main factor in creating the condition which gave birth to the problem."

"Problems of citizenship," said Morris Knowles, "are largely engineering in character"; and yet, when Sir Robert Borden issued his message on the fiftieth anniversary of Confederation, and proudly referred to the marvellous material development in Canada, as Fraser S. Keith mentioned in his address delivered at Ottawa on November 15th last, Sir Robert forgot to state that "each and every one of the indications of advancement owes its present state directly to engineering skill and to engineering progress."

Enough has been stated to show the opinion of various authorities on the desirable relation between the branch and the community. It will be well now to refer to what is being done in this direction, so that we may have some indication of the activities in which the branch may engage.

The Providence Engineering Society succeeded in 1917 in inducing the authorities to appoint an engineering committee to consider the preparedness of Rhode Island, especially with reference to the protection of plants and provision for the restoration of interrupted public service and other work which the engineers could probably do in the event of a serious conflagration or the like.

The Nashville Engineering Society in 1907, at the request of city officials, gave the city council assistance in connection with the method to preserve and secure a pure water supply. It afterwards co-operated with the fire commissioners and building superintendent to frame new building regulations. It assisted in the preparation of a uniform boiler code and in drafting national water power laws. It joined with the county authorities in connection with the question of highway bonds.

The Cleveland Engineering Society has been very active. It worked with the Chamber of Commerce to coordinate the industries of the city to effect a maximum of war production. It joined with the Builders' exchange and the Institute of architects to revise the building code. It assisted the Civil Service Commission in connection with examinations for engineering positions. It cooperated with the Y.M.C.A. and the Chamber of Commerce on the problem of vocational guidance for boys. It assisted with the City Planning Committee to preserve and beautify certain properties.

The Engineers' Society of Pennsylvania conducted Industrial Welfare and Efficiency Conferences. The Model Charter for Boulder, Col., was drafted by engineers. The Municipal Engineers in Britain, at their various meetings, not only offer criticism of the various civic enterprises which they visit and study, but also frequently submit valuable information to the authorities.

The Engineering Institute of Canada is by no means remiss in its service to the public. Its committee on transportation prepared a comprehensive report on the railway problem. It urged the government to make an investigation how the natural resources of Canada could best be developed.

The Toronto branch has also done some work on behalf of the community. The Saskatchewan branch offered to place the services of the members at the disposal of the provincial government to co-operate to the fullest extent when called upon and to give any information at their disposal, either as a consultory body or in an advisory capacity, concerning the qualifications of members of our profession. The British Columbia division made a similar movement.

It will be acknowledged that although we have done something in behalf of the public, the relationship is not extensive or intimate. In this respect we have maintained an attitude of partial isolation. The public knows very little of what we have done in this behalf. Prestige and influence in the community must more or less correspond to the extent to which we cultivate its confidence, goodwill and appreciation. A negative virtue meets with a negative esteem; or in other words, if we do not as a body serve the public, we cannot legitimately expect its high esteem. It has doubtless been observed by us all how few engineers represent the people in Parliament or on other public bodies. We seem to shrink from publicity and must suffer thereby, whilst public service is that much the poorer. The appointments of C. A. Magrath as fuel controller of Canada, and of R. A. Ross and A. Surveyer as members of the Honorary Advisory Council for Scientific and Industrial Research, suggest a satisfactory change in the attitude of the governments in their attitude towards the profession. The United States Government has utilized the services of engineers and engineering organizations in a larger measure.

The question will arise, What then can we do as a branch to enhance its prestige and influence?

We might co-operate with the Board of Trade and the Canadian Manufacturers' Association to study what industrial developments are desirable and possible, and how to promote them.

It would be desirable to join the Civic League and the Bureau of Municipal Research in the investigation of various problems associated with city affairs.

The employment of partially disabled soldiers is a very important subject. The branch might afford assistance in some direction to the governmental commissions.

(Continued on page 345)

METHODS AND COST OF SNOW REMOVAL*

By H. F. Richards
Superintendent of Maintenance and Repairs,
South Park Commissioners, Chicago

THE areas covered by the South Park Commissioners in their snow-cleaning work include about 67 miles of drives and 175 miles of walks and 90 to 95 acres of skating ice.

The South Park snow-handling equipment at the present time includes five 3-wheeled tractors fitted with detachable V-shaped plows having wing extensions and with detachable revolving street brooms, one 4-wheeled tractor equipped with both V-shaped and straight moldboard attachments, some very large snow-hauling wagons, twenty large 4-wheeled iron plows of the road grader type, seventeen large wooden 4-wheeled tractors fitted with detachable revolving street brooms, one 4-wheeled tractor equipped with both V-shaped and straight moldboard attachments, seventeen large wooden 4-wheeled plows similar to the road graders, six small iron-wheeled plows, used mainly for cleaning snow off sidewalks around the smaller parks, several straight moldboard attachments for auto trucks, and a considerable number of large ajax scrapers, triangle plows, ice shaving machines, etc., for cleaning the fields of skating ice.

About three winters ago a snow-slushing machine was constructed for the purpose of disposing of snow in the downtown district through the sewers instead of loading it on wagons and trucks and hauling it to a dump. This was a small machine, consisting of a water turbine with a supply line to a fire-plug, so patterned that it would hang in a sewer manhole in a wire mesh basket, three free blades connected with the turbine chopping the snow and with the aid of the water from the turbine exhaust forcing or washing it through the wire basket into the sewer where the current of water and sewerage took it away. The basket served to keep pieces of wood, bricks and other rubbish from passing along into the sewer and possibly clogging it.

In January of this year the abnormal snowfall plainly showed the necessity of a powerful and efficient machine to handle snow rapidly and in large quantities. After a little experimental work a 2-disk rotary snowplow was constructed and given some preliminary tests, but the lateness of the season did not permit perfecting it. With more power, however, it gives promise of being developed into a practical affair.

The following statement shows the cost of cleaning snow from the park driveways, the time required for carrying out the work being three days:

First Day (a.m.)—Plowing snow to the gutters from Washington Park stables to 12th Street and Michigan Avenue, over the following driveways:

	Width, ft.	Area, sq. yd.	Length, miles.
Washington Park (part)	40-50	30,000	1.20
Grand Blvd. (centre drive)	55	64,416	2.00
South Park Ave. (35th to 33rd) ..	42	6,122	0.25
33rd St. (South Park to Michigan)	42	8,282	0.31
Michigan Ave. (33rd to 12th)	50	67,320	2.25
	....	176,140	6.01

Cubic yards of snow on drive, at 4 in.	19,571
Cubic yards of snow on drive, at 6 in.	29,357

For a 4-in. snowfall it is estimated that 40 horses (5 right 4-horse hitches and 5 left 4-horse hitches) will be required to plow these drives in five hours before noon. At the rate of $6 per 8-hour day for team and driver, the cost will be $75.

For a 6-in. snowfall it is estimated that 48 horses (6 right 4-horse hitches and 6 left 4-horse hitches) will be required. At the rate of $6 per 8-hour day for team and driver, the cost for five hours' work will be $90.

Cost of Plowing Snow Off Above Driveways

	Per mile of drive.	Per 1,000 sq. yd. of pavement.	Per cu. yd. of snow.
For 4-in. snowfall	$12.49	$0.427	$0.00384
For 6-in. snowfall	14.98	.512	.00307
Total cost (without overhead) for 4-in. snowfall			$75.00
Total cost (without overhead) for 6-in. snowfall			90.00

First Day (p.m.)—In the afternoon half of the teams which plow from the park stables to 12th Street and Michigan Avenue in the morning will plow snow to the sides of the drives on—

	Width, ft.	Area, sq. yd.	Length, miles.
Drexel Blvd. (both drives)	*40	70,224	3.00
Oakwood Blvd.	50	17,060	0.50
Washington Park (part of drives)	40-50	20,000	0.80
The other half of the teams will plow—			
Garfield Blvd. (South Park to State)	40	11,733	0.50
Michigan Ave. (55th to 33rd) ...	50	82,228	2.75
*Each.	..	201,245	7.55

Cubic yards of snow on drive at 4 inches	22,360
Cubic yards of snow on drive at 6 inches	33,541

The cost of the afternoon's work (5 hours) will be the same as for the morning's plowing—$75 for a 4-in. snowfall and $90 for a 6-in. snowfall. These drives will not be gone over twice, but it is intended to go over the drives between the Washington Park stables and 12th Street on Michigan Avenue twice in order to get them as clean as possible, as the first trip over the drives usually does not remove all of the snow.

Cost of Plowing Snow Off Drives Cleaned in the Afternoon of the First Day

	Per mile of drive.	Per 1,000 sq. yd. of pavement.	Per cu. yd. of snow.
For 4-in. snowfall	$ 9.94	$0.373	$0.00336
For 6-in. snowfall	11.93	.448	.00268
Total cost (without overhead)			$75.00
Total cost (without overhead)			90.00

Second Day (Nine Hours' Work).—Half of the teams will plow to the gutters on—

	Width, ft.	Area, sq. yd.	Length, miles.
Garfield Blvd. (south drive—State to Western)	40-25	56,691	3.00
Garfield Blvd. (north drive—South Park to Western)	40-25	68,424	3.50
Other half of the teams will plow snow on—			
A.M.—(From park stables to 79th St. and Bond Ave.)—			
Washington Park (part of drives)	40-50	10,000	0.40
Midway (south drive)	40	21,910	1.00
Jackson Park (part of drives)	40	44,000	2.00
Yates Ave. (71st St. and Bond Ave. to 79th St.)	32-38	36,500	1.75
P.M.—In the afternoon over the following drives:			
Fifty-first St. (including Drexel Sq.)	40	31,976	0.94
East End Ave.	50	18,700	0.65
Jackson Park (rest of drives in "outer" circle)	40	70,000	3.00
		358,201	16.24

Cu. yd. of snow on drive: At 4 in., 39,800; at 6 in., 59,700.

As this is a 9-hour day, the cost of plowing the snow after a 4-in. snowfall, using 40 horses, will be $135, at the

*Abstracted from paper read before the Western Society of Engineers.

rate of $6 per 8-hour day for team and driver; in case of a 6-in. snow the cost will be $162, 48 horses being used.

Cost of Plowing Snow Off Drives Cleaned on the Second Day

	Per mile.	Per 1,000 sq. yd.	Per cu. yd.
For 4-in. snowfall	$ 8.31	$0.378	$0.00340
For 6-in. snowfall	9.98	.453	.00272
Total cost (without overhead) for 4-in. snowfall			$135.00
Total cost (without overhead) for 6-in. snowfall			162.00

Third Day (Nine Hours' Work).—One-half of the teams will plow snow to the sides on the following drives:

	Width, ft.	Area, sq. yd.	Length, miles.
66th and 67th Sts. (Jackson Park to Ashland)	28	67,518	4.10
*Normal Ave.	32	63,580	2.10
Other half of the teams will plow—			
Grand Blvd. (side drives)	†25	58,432	‡4.00
Washington Park (rest of "outer" circle of drives)	40-50	45,000	1.60
		234,530	11.80

*Cu. yd. of snow on drive: At 4 in., 26,060; at 6 in., 39,096. †Each. ‡Together.

At the rate of $6 per 8-hour day for a team and driver, the cost of plowing a 4-in. snowfall, using 40 horses, will be $135; for a 6-in. snowfall the cost will be $162, 48 horses being in use.

Cost of Plowing Snow Off Drives Cleaned on Third Day

	Per mile of drive.	Per 1,000 sq. yd. of pavement.	Per cu. yd. of snow.
For 4-in. snowfall	$11.44	$0.576	$0.00518
For 6-in. snowfall	13.74	.692	.00415
Total cost (without overhead) for 4-in. snowfall			$135.00
Total cost (without overhead) for 6-in. snowfall			162.00

The above costs are based on a rate of 75 cents per hour—$6 per 8-hour day—for a team and driver. They do not provide for finished cleaning over the various driveways of the South Park system, but cover primarily the clearing away of the "roughage" after snowstorms, such as can be accomplished by a single trip of the battery of plows over the different drives. Where two teams are used on a grader plow, the second driver operates the plow adjustments, so no laborers are necessary in such cases. As will be seen, the cost per mile for cleaning, outside of the downtown district, ranges from $8.331 per mile as the minimum for a 4-in. snowfall to $14.98 per mile as the maximum cost for a 6-in. snow, two teams being used on each grader.

In some instances but one team is used on a grader and then a laborer is required to man the plow. It has been found that this reduces the cost of a single trip, cleaning of a certain driveway, making it from $5.40 per mile for a snow of 4 to 5 ins. to $7.20 per mile for a fall of from 5 ins. to 1 ft., when the team hire is $6 per 8-hour day and the rate for labor is 30 cents per hour.

Carefully kept records show that the work of cleaning snow off drives with tractors after ordinary snowfalls can be done at a cost somewhat less than with horse-drawn machines and with them the work progresses much more rapidly, too. In breaking up packed snow and ice the tractor outfits have proved themselves particularly adapted, while they are able to pile the snow over the curbing better than horse-plows, leaving the gutters open.

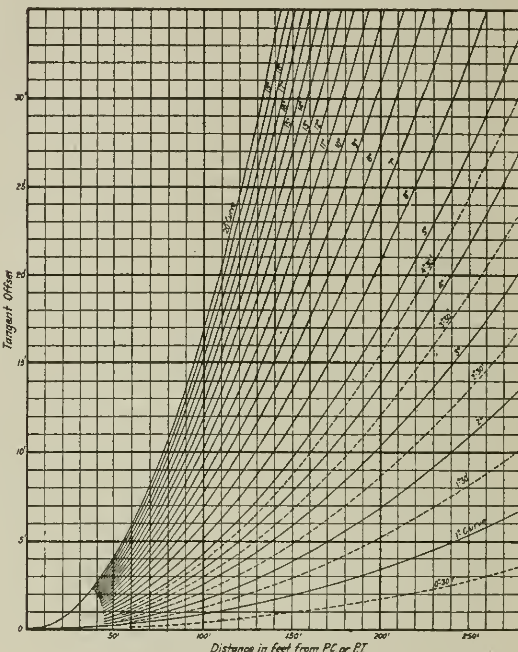
In a paper read before the Ottawa Branch of the Canadian Society of Civil Engineers on Thursday last, April 12th, Lieut. Edgar A. Jamieson brought out many interesting points in gun manufacture.

LAYING OUT CURVES BY TANGENT OFFSET*

THIS chart is for the use of highway engineers, and is made a convenient size for pasting in the field book. When plotted to a larger scale, interpolation can more readily be made.

By use of the cross-section paper on which the chart is made and the scale that is adopted, each 10 ft. in distance and each 0.2 ft. in offset is readily taken from the chart and other distances can be interpolated.

It is not intended to discourage any accurate method of laying out curves, but in highway work the tangent offset method is sufficiently accurate in the majority of cases, and this chart is designed to save field calculations.



If used in connection with a well-arranged set of tables of the one degree curve, such as Table 30 in "Harger and Bonney's" handbook, it will practically eliminate figuring in the field and speed up the survey considerably.

The following instructions accompany the chart:

In measuring up to the P.I., leave temporary markers at stations and plus stations where the curve is to be located. From the newly located P. I. turn off the desired deflection angle. Determine the degree of curve necessary to fit the conditions from the external and tangent length and take from table the tangent and length of curve, and record the station of the P. C. and P. T. Make the curve correction for difference in length of the sum of the tangents and distance on the curve at the P. I., and start measurements along next tangent, leaving temporary markers up to the P. T. of the curve. To lay out curve, start at the station or plus station near the P. C. and measure along the curve, using standard chord lengths, and using the offsets from tangent as read from chart, which increases as the distance from the P. C. or P. T. increases.

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*"Engineering and Contracting," New York.

SOME PRACTICAL POINTS IN THE DESIGN AND CONSTRUCTION OF PARTITIONS*

By H. L. Barraclough

HAVING been asked to write something on the use of partitions, I had almost thought their common use and infinite variety would scarcely have required anyone to ask further information on the question, a matter of some difficulty, owing to the simplicity of construction.

Like many other things, the war has brought partitions into an almost endless number of uses, one of which has been for the building of huts and houses. Though this may be new to some, the writer has been concerned in the building of schools and sanitoria, some years ago, with plaster slabs, cement rendered outside, and those places stand to-day as good as when erected.

When partition slabs were first used they had to meet some stern opposition from those always present in a community who oppose anything new. Even to-day one meets with people who are opposed to innovations. However, we may thank the evils of war for dispelling some objections concerning partitions.

Simple as it may seem, the erection of partition slabs, as experience has proved, should only be entrusted to the hands of men used to this particular class of work. A badly built-up job is sure to develop cracks in unthought-of places, the blame very often being fixed on the manufacturer of the particular partition slabs. This long-suffering individual very often has little means of replying to the criticisms, where the slabs alone are supplied by him.

There are several kinds of partition slabs manufactured and on the markets: Breeze, pumice, plaster and clay, each of which has its special claims.

Plaster, until recently, has been the most common in use, and has many advantages over breeze slabs. Solid plaster slabs are light, easily fixed, with little or no waste in erection. When up, they form a solid wall, hygienic in all ways, as every possible lodgment for dirt and vermin is effectually closed after the walls has been plastered out, and are fire and sound-resisting, provided the work has been executed by skilled labor, which goes largely to ease the question of after-cracks.

My opinion is, that hollow plaster slabs, although lighter, have some objectionable features, the compressional strength of the slab having been somewhat destroyed through the apertures; and further, if spiking is resorted to for fixing, very often the spikes crack the slabs when being driven in, and generally weaken the whole wall.

In fixing plaster partition slabs, it is essential that the suction should should be destroyed by applying a thin cement wash, and that they should be well bedded in plaster in preference to spiking.

It is preferable that all slabs, used for partition work, should be tongued and grooved horizontally and vertically, and in fixing, the grooves should be placed upwards and the joints broken, as in brickwork, and the vertical joints carefully grouted in with plaster, both where they join up to the door frames or brick walls and where they butt against each other. Where a slab has to be cut it is advisable to form a groove by scooping a piece out.

Plaster slabs have been successfully used for external works fixed on wood framings and faced with tiles, but this is an expensive form of work, and if not carried out by experienced labor, the tiles are liable to come off.

Seven years ago two-inch plaster slabs were used for internal and external walls of a school in Northumberland. The slabs were fixed to wood framing on outside, rendered over surface with cement, mortar floated to an even surface and rough cast with a mixture of slag and pea gravel, one-inch internal slabs nailed to framing floated and skimmed with washed haired lime and putty, and finished with putty and plaster throughout, a dado of 3 ft. 6 in. being formed with Portland cement back, and finished with Keene's cement, face trowelled smooth. It has proved a very satisfactory construction, as well as cheap.

A well-known firm has recently introduced a plaster slab with a special face to receive cement rendering for external work, and they claim that it will withstand the weather for twenty years without being re-rendered. These have been used for external works on several jobs in the Midlands, and would appear to be eminently suitable for a cheap-system cottage or bungalow building. This system could be used in conjunction with light, reinforced concrete piers and beams or wood framing, and has the advantage of being a very rapid construction. Doors and windows can practically be fixed in any position, as the openings can easily be cut, after the wall is up, without much danger of damaging other parts.

The foundation need only be 9 in. depth of good concrete under the wall, weathered on the outside, doing away with the necessity of any damp course.

Breeze partition slabs are manufactured by several firms, in various sizes and shapes. They are light, and one on the market, to my knowledge, affords a first-class key for fixing, and is cast with an indentation with horizontal edges. There is always a danger that the breeze used in manufacturing slabs may contain sulphur, which will in time discolor the plaster and cause it to scale off; and where the partition is faced with tiles, the latter will crack and often fall off from the action of the sulphur, which seems to go on for a long time, thus causing much annoyance and anxiety, and where used it is advisable that the slabs should be obtained only from a firm of sound repute.

The pumice slab is a very light form of construction, convenient to handle, and is manufactured from pumice and volcanic sand (imported into this country from Italy), mixed with Portland cement. These slabs form a rigid construction when up. Nails can readily be driven into them and take a good hold, doing away with the necessity of plugging for fixing skirtings or picture-rails.

The hollow terra-cotta partition tile is well known to many, and can be obtained in different sizes from several firms, and has the advantage of being easily handled. It can be obtained with a keyed or smooth face, and is being used just now extensively for exterior work. It is easily built up, the horizontal joints being bedded with cement, and the vertical joints grouted up, and seems to be quite effective in withstanding the weather, but it has only come into prominent use for this purpose recently, owing to the present shortage of other materials, and it remains to be proved what effect time will have on it. I am, however, strongly of the opinion that there are several points in its favor for this purpose, being cheaper than a brick wall of the same thickness, resists the damp better and ensures a more even temperature, but does not lend itself to nailing. Where it is necessary to fix skirtings and rails, provision should be made for same

*Paper read before the Concrete Institute, March 21, 1918.

at the time of erection by carefully inserting plugs in the joints. Should this not be done at the time of erection, and it is found necessary to fix electric fittings or hook-rails, the joints should be cut out and a plug built in, as any attempt to drive a nail into the tile is generally a failure, besides being liable to break the face of the whole tile.

Those of us who have had to do with partitions know only too well that they mostly have the annoying habit of showing cracks, which, more often than not, go right through. These cracks may develop from either of the following causes:—

The cracks generally occur just under the ceiling or near walls and door frames, or at top corners of door frames. The cracks at the tops or by the walls may be caused by variation of temperature, causing expansion or contraction, or through the supports deflecting or settling. Cracks also are generally to be found on top stories of buildings with large flat roofs, owing to the expansion of the flat as well as the partition, and up to the present I have not seen any successful method of stopping this occurring with a built-up partition, for even when cut and carefully filled in, the cracks will readily appear again.

The cracks on doors are particularly noticeable when the jambs project a few inches above the frame, and this is caused by the wood frame swelling, through absorbing the moisture from the partition whilst it is being erected. These can generally be stopped up successfully if cut out and filled in, after the partition has had time to dry out, and will not appear again, provided the door frames are fixed rigidly enough to prevent the partition from being shaken when the door is shut quickly. The best remedy, however, is to prevent this by stopping the door jambs off flush and carrying the partition over in one slab. This method is now recognized by most practical fixers as the best, and, with few exceptions, is carried out wherever possible.

The position of a partition is too often left to be settled after the floor and beams are all in, and then it is placed anywhere, whether the weight is supported by a main beam or only by the floor, and more often than not is placed on the floor, away from the main beam, which may only be calculated to carry a load of 100 lbs. per foot super; whereas many 3-in. partitions, when plastered both sides, weigh 18 lbs. per foot super, and 10 ft. is quite an ordinary height for such a partition; therefore, one foot run would weigh 180 lbs. The heaviest articles of furniture in domestic buildings are generally placed against the partition, and in an office it is quite an ordinary occurrence to find a heavy safe one side and a tier of shelves filled with books and papers on the other. Taking the total weight of the safe at 15 cwts., placed in the centre of the bearing, and the bookcase at 2 cwts. per foot run, we find, if a 3-in. partition, 12 ft. wide × 10 ft. high, happens to be placed on the floor, as per diagram, we get the following load per foot super in that particular place:—

	Pounds.
3-in. partition—18 lbs. per ft. sup. × 12 ft. wide × 10 ft. high = a distributed load of......	2,160
One safe = a distributed load of 30 cwt. = ...	3,360
One tier of shelves, 10 ft. wide, at 2 cwt. per ft. run = 20 cwt.	2,240
Giving a total load of........................	7,760

Taking the width of floor occupied as 3 ft. × 12 ft. = 36 ft. sup.

Therefore, 7,760 lbs. ÷ 36 = 215.5 lbs. per ft. sup. on this particular portion of the floor, which is more than double what the floor weight and main beams were calculated to carry, and, except for the large safety factor required by the authorities, there would be more than mere cracks appearing. The writer is strongly of the opinion that the position of all partitions wherever possible should be settled at the time of planning, and proper beams arranged to carry them, and when this cannot be done, it is advisable wherever possible to have partitions cast in situ and reinforced with small, steel rods, forming a beam from wall to wall. This method has been carried out by me, and has always proved most satisfactory, and helps very considerably to tie the wall and distribute its load more evenly, and costs very little more than a built-up partition; being quite solid in construction, it is thoroughly hygienic.

There is yet another means by which a partition can be constructed without slabs, and where a very thin partition is required, it has many advantages, as when finished and the whole thoroughly set, it forms a very strong and rigid structure, being light, occupying little space, and being practically sound, fire and vermin-resisting. There is no temporary sheeting or strutting required, and the work can be done with little labor.

The foundation work usually consists of vertical rods, securely and tautly fastened at top and bottom by screws, nails or clamps at about 12-in. centres. To these supports expanded metal lathing is firmly secured by soft wire or some other convenient means, and both sides covered by any quick and hard-setting plasters, which can be finished to a smooth face without loss of time.

The solid partitions are sometimes built only 1½ in. thick, but generally made to finish 2 in. thick, and can be used in combination with any class of concrete floors and ceilings, or ordinary wooden floors. Doors and other openings that may be required for lifts or ventilation can easily be formed and frames securely fixed in position at the time of construction, or after the partition is up. The whole forms a partition possessing all the desired advantages of a divisional wall not required to carry any weight, and occupies the least possible space for such purposes. This class of partition is very suitable for internal lift wells, where good anchorage can be obtained for the vertical tie-rods, as it takes up little room and stands vibration.

These are only a few of the many classes of fire-resisting partitions, but I have endeavored to include those most generally used. I have evaded mentioning the names of any particular manufacturers, as many are known to all of you, and I trust that you have not been bored by my effort to explain a few practical details in connection with my experience of the past.

As mentioned previously, one of the most troublesome things in connection with partitions is their habit of cracking. I hope, however, that some useful information regarding a cure for the complaint may be brought out in discussion, as no doubt partitions will play an even larger part in future constructions of small property than they have done in the past.

TORONTO BRANCH, AM. INST. OF E. E.

The Toronto section of the American Institute of Electrical Engineers held a meeting last Friday, when W. P. Dobson read a paper on "High Voltage Phenomena." One hundred and ten members of the section were present.

KETTLE RAPIDS BRIDGE*

By W. Chase Thomson, M.Can.Soc.C.E.

THE Hudson Bay Railway extends from The Pas, the northern terminus of the Canadian Northern Railway in Manitoba, to Port Nelson, on Hudson's Bay, a distance of 424 miles. The grading has been completed throughout, and the rails have been laid to mile 332.

There are three important bridges on the line: The first crosses the Saskatchewan River at The Pas, and comprises four fixed spans of about 150 feet each, together with a swing-span of about 250 feet; the second crosses the Nelson River at Manitou Rapids (mile 242), and is a handsome structure of conventional deck cantilever type, with a channel-span of 304 feet 6 inches and anchor-spans of 108 feet 9 inches, supplemented by an 85-foot plate-girder span at the north end; the third, which is the subject of this paper, is at the second crossing of the Nelson River, or Kettle Rapids, (mile 332), the present end of steel.

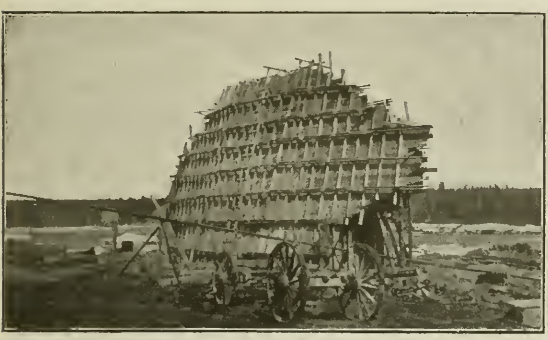

Fig. 1—Abutment 1 Under Construction

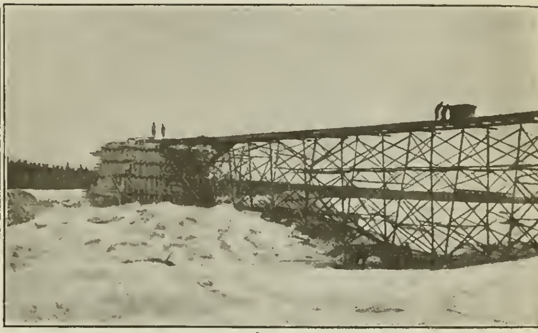

Fig. 2—Pier 2 Under Construction

The Nelson is one of the great rivers of Canada, its drainage including the prairies of Alberta, Saskatchewan and Manitoba on the west, the Red River Valley on the south and part of Ontario on the east; but, owing to the intervention of Lake Winnipeg, which serves as a huge reservoir, the flow of water in this river throughout the year is remarkably uniform.

The main channel at the bridge-site is only 350 feet wide, and estimated to be about 200 feet deep at the centre; the current is very swift, and there is always a certain amount of open water. Directly above and below the bridge-site, however, the river freezes all the way across, but only after the jamming of the ice and the consequent rising of the water. There can never be any danger from ice, either to the superstructure or to the piers, for the steelwork is 15 feet clear of the highest fixed ice-peaks, and there is running-ice only when the water-level is much below its maximum elevation.

In locating the line, advantage was taken of two very conveniently-placed islands, allowing a central span of 400 feet, with piers and abutments on the solid rock. This rock is of pre-cambrian origin, and is a tough granitoid gneiss.

The bridge is a continuous structure, 1,000 feet long, having a channel-span of 400 feet and two side-spans of 300 feet each. The trusses, or main girders, are of the sub-divided Warren type, 50 feet deep throughout, 24 feet apart, centre to centre, having 25-foot panels. There are two lines of stringers, 8 feet apart, centre to centre; and the base-of-rail is 17 feet 6 inches above the centre-line of the bottom-chords. The structure is riveted throughout, and all bracing is rigid; it is fixed at Pier 3, and provided with expansion-rollers at all other bearings. The ties are 8 x 12 inches, 14 feet long, spaced 12 inches, centre to centre; they are notched ½ inch on the stringers, and every fourth tile is fastened thereto by a ¾-inch hook-bolt. The outer guard-timbers are 8 x 9 inches, spaced 10 feet 10 inches in the clear; they are notched one inch and secured to every fourth tie by a ¾-inch bolt. Steel guard-rails, weighing 60 lbs. per yard, are provided inside of the running rails, with 8 inches clearance between heads. They are brought together in a frog beyond the ends of the bridge. The main (or running) rails are of the American Society of Civil Engineers' standard section, weighing 80 lbs. per yard. At Abutment 1, where the total expansion and contraction of the bridge will be about 8 inches, they are provided with specially-designed expansion-joints of the split-switch form, with points of manganese steel. Refuge-bays, for pedestrians, are provided at intervals of 200 feet.

Three types of bridges were practicable for this location: First, simple spans, with temporary members over the piers for cantilever-erection of the channel-span; second, the conventional cantilever bridge, with a central freely-suspended span; third, a true continuous-girder bridge. The first would have been satisfactory, but uneconomical, owing to the great weight of extra metal required for erection stresses only. The second was rejected partly on account of the objectionable articulated joints at the end of the suspended span, but principally because of the expensive shop and erection work in connection therewith; for an economically-designed cantilever structure would have required a much greater depth over the piers, with considerably less depth at the abutments and for the suspended span, resulting in sloping chords and irregular webbing; besides, in order to obtain such economical proportions, it would have been necessary to locate the bottom-chords as close to the base-of-rail as possible, thus largely increasing the quantity of concrete in the structure.

The third type, as designed and built, is the most rigid of all, and the most economical; for it required no extra metal for erection-stresses, except in the bottom-

*Abstracted from paper read before the Montreal Branch of the Canadian Society of Civil Engineers, April 11th, 1918.

Fig. 3—Southern Anchor-span Erected; and Beginning of Cantilever Erection, Showing Temporary Supports for Panel-points L14

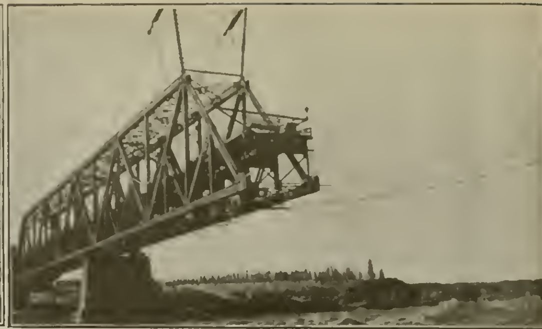

Fig. 4—Southern Half of Bridge Erected

chords of the channel-span adjacent to the piers, where the increase of section was slight; the simplicity and uniformity of the framing reduced the cost of fabrication to a minimum; and the continuous horizontal chords, without adjustable joints, greatly facilitated the work of erection. It is admitted that continuous-girder bridges have been regarded somewhat unfavorably in the past, for it has been claimed that the usual theory for computing the stresses therein, which assumes a constant moment of inertia, is inexact; that the computation of the stresses is too difficult and tedious. Finally, that the least settlement of any support would radically alter the stresses, and thus endanger the structure. No doubt, in the old days of pin-connected bridges, continuous girders were undesirable in many respects; although a notable example of such a structure, which has received much praise and which gave excellent service for many years, was the old Canadian Pacific Railway bridge at Lachine. Now that pin-connections have been almost entirely superseded by riveted joints, continuous girders are growing in favor; and the most remarkable example of such construction is to be found in the recently-constructed Sciotoville Bridge over the Ohio River, comprising two continuous spans of 775 feet each.

Regarding the objection that the computed stresses are inexact, it may be stated that, in the present instance, the reactions were first computed for panel-concentrations by formulæ as given in Merriman and Jacoby's "Roofs and Bridges," Part IV., pp. 12 and 13, and afterwards checked by the elastic method. The difference in the results obtained by these two methods was less than ½ of 1 per cent., which should satisfy the most exacting. This close agreement was undoubtedly due to the parallel chords and nearly constant moment of inertia; but, in the most extreme case, the error due to the use of the formulæ would probably not exceed 6 per cent.

The objection that the labor of computing the stresses for continuous girders is too difficult and tedious is unworthy of notice, especially where a large and important structure is concerned.

Finally the claim with reference to results that would be produced by a possible settlement of one or more of the supports is more rational, but much exaggerated; for continuous girders are very elastic structures, and can accommodate themselves to small settlements of supports without developing serious alterations of stress in their members. In this case, the ends of the trusses, if unsupported, would deflect 25 inches below the horizontal line from dead-load; and the alteration in the dead-load reactions at the abutments, due to raising or lowering the end supports a whole inch, would only be 9,500 lbs., or 4 per cent., whilst the reactions and stresses for the live-load would not be affected at all. Moreover, it is inconceivable that any settlement of the foundations can take place, as they are all on the solid rock; otherwise, this design would not have been adopted. Furthermore, in order to provide for possible small inaccuracies in fabrication or erection, the ends were made adjustable by

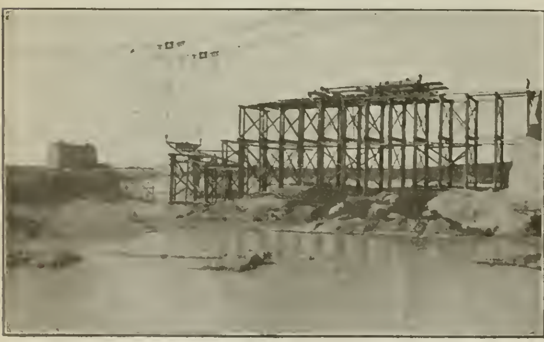

Fig. 5—Falsework Under Construction for Northern Anchor-span

Fig. 6—View of Cableway; and Beginning of Erection of Northern Anchor-span, with Traveller at Floor-level

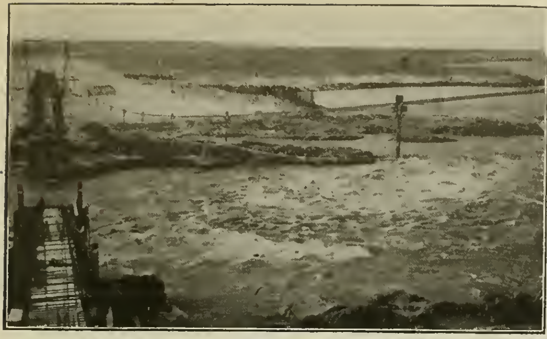

Fig. 7—View from Top of Cableway-tower

Fig. 8—Lower Steelwork for Northern Anchor-span Erected; Traveller Raised on Blocking, for Working on Top-chords

allowing 1⅝ inches for shims between the shoe-castings and the bottom-chords; and hydraulic jacks, with gauges attached, were used to set the ends at the height necessary to obtain the computed dead-load reaction. In this connection, and referring again to the Sciotoville Bridge, the following quotation from an article by Clyde B. Pyle, published in "Engineering News-Record," January 31st, 1918, will be of interest:—

"One of the most striking features of the entire erection was the curve for the last few inches of the jacking, after the steel towers were both free. The computed increment for each inch of lift was 7.5 tons; and the actual increase in load was too small to be read on the gauges.

"It is quite evident from this condition that, for long-span continuous trusses, it is not as vital a point as was formerly thought to be the case to have the supports at exactly correct elevations. In this case an error in setting one of the end supports, say, as much as 3 inches, would have changed the end reaction 22.5 tons, or the stress in the end-post 32 tons, which would be less than the probable error in computing the actual stress in that member. The worst condition of shop-work, erection and setting of shoes could not possibly total more than one inch; so that the certainty of stresses and therefore the safety of such a bridge is left without question.

"The fact that complications enter into the design and erection cannot bar the use of such bridges as long as they are economical. The reasons usually given, that the stresses are not statically determinate and that uncertainties of stresses result from slight errors in elevation of the supports, are no longer valid."

Details of Design

The structure has been designed in accordance with the General Specification for Steel Bridges, issued by the Department of Railways and Canals in 1908, except for a slight modification in the impact formula, affecting alternating stresses only, and a change in the allowable unit-stresses for compression members.

In the matter of impact, when dealing with alternate live-load stresses, the Department's specification requires the impact to be computed by squaring the arithmetical sum of the tension and compression stresses due to the live-load (or the range of stress), and dividing by the maximum algebraic sum of co-existing dead-load and live-load stresses, or $I = \frac{range^2}{max.}$. Now, taking an extreme case in which a member is subject to alternating live-load stresses of equal amounts, but no dead-load stress, the impact would be $\frac{(L + L)^2}{L} = 4L$, or four times the live-load stress of either kind, which is certainly excessive. If, however, we take for the *range* the live-load stress of one kind and add to it 4/10 of that of the other kind, we have $\frac{(L + 0.4L)^2}{L} = 2L$, approximately, or an impact equal to twice the live-

Fig. 9—View Showing Cableway With Its Equalizing-Girder; Derrick-car on Southern Cantilever; Traveller on Top-chords of Northern Anchor-span

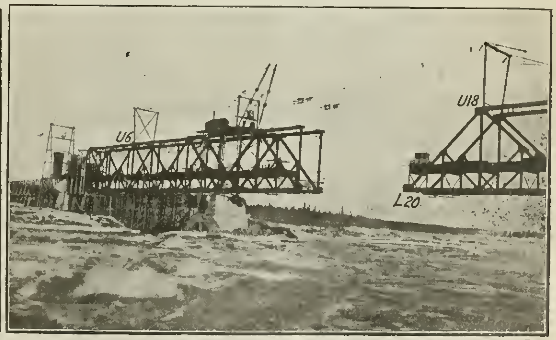

Fig. 10—Northern Anchor-span Erected, Also 100 Feet of Adjacent Cantilever. Note Additional Rocker-bent at U6 for Supporting Cables

load stress of either kind, which would seem to be ample. In conformity to the above argument, impact has been computed by the formula, $I = \frac{range^2}{max.}$, with the arbitrary stipulation that the *range* shall be taken as the arithmetical sum of the live-load stress of the greater kind and 4/10 of that of the lesser. When the live-load stress is of one kind only, the formula reduces to $I = \frac{L^2}{L + D}$, in which L = live-load stress and D = dead-load stress.

Concerning the unit-stresses for compression-members, the Department's specification calls for 16,000 lbs. per square inch reduced by Gordon's formula, using in the denominator the factor 18,000 for square ends, 12,000 for one square and one pin-end, and 9,000 for pin-ends. It is now quite generally recognized, however, that 16,000 lbs. per square inch is entirely too high for short columns; and the Joint Committee on Columns and Struts in the United States, which has recently submitted its final report, recommends a maximum working unit-stress of 12,000 lbs. per square inch, which is therein shown to provide a factor of safety of 2, or the same as for tension members when designed for a unit stress of 16,000 lbs. per square inch on the net section. In the General Specification for Steel Highway Bridges, recently adopted by the Society, the formula for compression members is 12,000 — $0.3\ (l/r)^2$, which becomes zero when $l/r = 200$. In this bridge, the compression members have been designed in accordance with the formula $12,000/1 + \frac{(lr)^2}{36,000}$, which agrees closely with that adopted by the Society for values of lr up to 70, but gives somewhat higher unit stresses for greater working ratios.

Latticing of main members has been avoided as far as practicable; but the open sides of compression chord members are double latticed with 5 x ⅝-inch flats, having two rivets at ends and at intersections. Tension chord members are similarly latticed with 5 x ½-inch flats. All of the principal web members are provided with substantial longitudinal diaphragms, which are considered as part of the effective section thereof; and heavy compression diagonals are further stiffened by tie-plates on their outstanding flanges. All joints and splices are fully riveted throughout.

Rocker-bearings are provided throughout, having 8-inch bearing-pins at the piers and 6-inch bearing-pins at the abutments; and the shoes are steel castings. The bridge is fixed at pier 3 and movable at pier 2 as well as at the abutments. At pier 2, the expansion rollers are 8 inches in diameter, and each set is provided with four 12-tooth cut pinions to prevent skewing. Substantial curtain-plates are supplied for the protection of the gears and to keep out the dust; but they are removable for inspection and cleaning of the bearings. At the abutments, the expansion rollers are 6 inches in diameter and similarly provided with alignment gears and curtain plates. The fixed bearings at pier 3 are similar to the expansion bearings at pier 2, except for rollers and bed-plates. The bridge-seats are tool-dressed perfectly level and to the exact elevations called for on the drawings; and sheet-lead, ⅛ inch thick, is provided to equalize any minor irregularities of the surfaces.

Owing to the small deflection of this bridge, which is only 3 inches at the centre of the channel span, for dead-load combined with the maximum effect of the live-load, it was considered unnecessary to provide for a perfectly straight bottom-chord under any particular condition of loading; so the trusses have been cambered, in accordance with the more usual method employed for simple spans of moderate length, by increasing the length of the top-chord panels.

Fig. 11—View of Bridge from South Shore Before Cableway and Traveller Had Been Dismounted. Note that the Lower Members of the Portal-struts and Sway-Bracing are Missing; They Were Omitted Temporarily for the Accommodation of the Derrick-car

Fig. 12—General View of Bridge, Taken from the South Shore and Looking Up-stream

The total estimated weight of steel in the structure (including floor-bolts), computed from the writer's detail drawings before the contract had been awarded, was 4,424,000 lbs.; and the actual shipping weight, as determined by the scales, was 4,415,000 lbs.

(NOTE—The author here gives a detailed and interesting account of the erection, which is omitted from this abstract, the erection program having already been described by Sterling Johnston, assistant manager of construction, The Canadian Bridge Co., Limited, in an article in *The Canadian Engineer* for March 7th, 1918.—EDITOR.)

Substructure

The substructure is of concrete throughout, composed of pit-gravel and cement, in such proportions as were found by trial to give the best results. It had been intended to construct at least the abutment and pier on the southern side of the river during the autumn of 1916; but the track did not reach the bridge site until the end of October; cold weather set in shortly after, and there was barely time to construct the foundation for abutment 1.

Excavation for this foundation was carried to a depth of over 10 feet, through frozen clay and silt, to the solid rock. The concrete was placed during the second week in December, and in very cold weather; but the materials had been heated, the mass was large and the result was entirely satisfactory, as found from a careful inspection the following spring. The abutment was completed during the month of April, 1917.

Operations at pier 2 were begun on April 10th, and under very adverse circumstances; for the river was then at elevation 328.0, or 10 feet above the average rock-surface at this point; and the rock was covered with a solid mass of ice, 25 feet thick. However, it was necessary to get ahead with the work as rapidly as possible; so the ice was excavated, and the rock was bared by May 5th, at which date the water had fallen to elevation 325.0. Although the ice-walls of the excavated shaft appeared to be perfectly solid throughout, the water percolated through and stood at the same elevation as that in the open river-channel; but it was perfectly still, without current or surge. A timber caisson, conforming on the bottom to the irregularities of the rock-surface, was then constructed; and all small openings therein were sealed by sheet-piling, carefully scribed and driven so as to broom the ends thereof. Every inch of the rock-surface inside of the caisson was then picked with needle-bars, to insure that it was entirely clear of ice; and heated concrete was deposited by deep-sea buckets. The rock-surface at this pier had previously been carefully examined during low water, and found to be absolutely sound; thus every confidence may be placed in the foundation. The footing for this pier was completed on May 9th; the construction of the main shaft thereof offered no difficulties, and was effected without incident.

At pier 3, no difficulties incident to water or ice were encountered; for work at this point was not started until June 29th; but there was a horizontal fissure in the rock at about elevation 322.0, which necessitated blowing up by dynamite the overlying mass. This resulted in giving an entirely satisfactory though very irregular foundation, to which the footing for the pier was made to conform.

Excavation for abutment 4 was commenced on June 14th, and was carried through about 10 feet of frozen clay, silt and boulders to the solid rock. The footing, up to elevation 341.5, was completed July 21st.

The pit-gravel, used throughout on this work, was invariably frozen and required to be thawed by steam; thus all of the concrete was placed warm, and with most gratifying results; for, on removal of the forms, not a single bad spot was discovered.

The butterfly wing-walls of the abutments were reinforced by twisted steel rods, one inch square, placed 3 inches from the rear surface. There were horizontals, 6 inches apart, wired to verticals, 3 feet apart. In addition, two such rods were placed along the upper edge of the wings. The total quantity of concrete in the work is about 3,000 cubic yards; and of reinforcing steel in the wing-walls, 2,300 lbs.

Surveys Were Accurate

The laying out of the work was difficult and tedious, owing to the irregularity of the ground and to the necessity of locating pier 3 by triangulation; but the instrument work was done with such care and precision that all important dimensions and distances were afterwards found to be practically exact. In locating the centre-line of bed-plates on pier 2, and that of the shoe-castings on pier 3, where great accuracy was desired, the piano-wire method of measurement was used, taking into account the pull on the ends of the wire and the corresponding sag, as determined on a level surface, and making the proper correction for temperature. The distance between centres of bearings on piers 2 and 3 was afterwards found to agree with the steel structure, as built, within 5/16 inch. It had been specified that the centre-line of the expansion-shoes should coincide with that of the corresponding bed plates at a temperature of 30 degrees, Fahrenheit; and, on inspection, with the thermometer at zero, the centre-line of the roller-shoes at pier 2 was found to be exactly 1 1/4 inches northerly of the centre-line of the bed-plates, instead of 15/16 inch, the amount of contraction in the steelwork in 400 feet for a fall in temperature of 30 degrees. Thus the distance between the bearings was too great by 5/16 inch. If there had been any appreciable error in the setting of the bearings on these piers, it could have been rectified, as provision had been made for jacking-up the structure, if necessary; but, as the dead-load reactions here are about 500 tons each, and the shoes very awkward to move, any such adjustment after erection would have been difficult and expensive.

The entire work has been under the general supervision of W. A. Bowden, chief engineer, Department of Railways and Canals, Ottawa; and of J. W. Porter, chief engineer, Hudson Bay Railway, The Pas. It was designed in full detail by the writer, who has been retained throughout for consultation in connection therewith. The substructure was fabricated and erected by the Canadian Bridge Company, Limited, Walkerville, Ont. T. B. Campbell, bridge engineer, Hudson Bay Railway, was in charge at the bridge-site, under whose immediate supervision the concrete work was constructed, and by whom all lines and elevations for the erection of the steelwork were given; I. E. Mahon was the superintendent of erection for the bridge company; and James Carr, representative of the Canadian Inspection and Testing Laboratories, Limited, attended to the field inspection. The entire work has been carried out without loss of life and without a serious accident.

Great credit is due to Messrs. McDonald Brothers for the excellence of the concrete work; to Mr. Campbell for the accuracy of his lines and elevations and for his efficient supervision; to the engineers of the bridge company for their splendidly conceived and carefully prepared scheme of erection; to the shops for the neatness and accuracy of workmanship; and finally to Mr. Mahon for his skill and care in handling under difficulties this important and somewhat unusual erection.

ASBESTOS OUTPUT INCREASED

The production of asbestos continues to increase under the stimulation of war demand. The product has been marketed at much higher prices and the total sales show a substantial increase. Stocks on hand at the end of 1917 were slightly in excess of those reported at the end of 1916.

In addition to the production in the province of Quebec, which is derived from the asbestos areas at Black Lake, Thetford, Robertsonville, East Broughton and Danville, there is a small output of crude asbestos amounting to 10 tons, valued at $2,150, produced and shipped from the Porcupine district in the province of Ontario. These Ontario operations have been discontinued for the present, but indicate the possibilities of sources of supply other than the well-known areas in Quebec.

Exports of asbestos during the calendar year 1917 were 93,932 tons, valued at $4,903,326, or an average of $52.20 per ton and asbestos and waste 52,088 tons, valued at $430,956, or an average of $8.27 per ton. There was also an export of manufactures of asbestos, valued at $55,666.

CONCRETE IN WESTERN CANADA*

By J. F. Greene
Construction Engineer, Carter-Halls-Aldinger Co., Winnipeg, Man.

At the very beginning, the writer wishes to apologize to any who may have the conviction that he is prepared to offer conclusions, based upon exhaustive evidence, covering the durability of concrete in Western Canada. When asked for a paper upon the subject, he begged to be excused upon the ground that his experience in Western Canada has been confined to two isolated communities, Calgary and Winnipeg, and that it had been of short duration. In reply it was urged that the society, realizing the importance of the issues involved, had determined to make a complete investigation, and that a paper at this time would serve as an entering wedge in this investigation. Inasmuch as the writer's firm had been engaged on the underpinning of the Grain Exchange, and as it was well known that an instance of serious deterioration of concrete had been found there, he was asked to assume the obligation of opening the investigation. The writer's part was to be that of the actor who appeared at the opening of a Greek drama, whose function it was to disclose to the audience the narrative of previous events, a knowledge of which was necessary for the proper understanding of the action of the play which was to follow. If in the course of this narrative, he should bring out many things which are not new, you will bear with him on the ground that he is treating a subject with which most of you are familiar, and because the presentation of these facts is necessary for a proper statement of the case.

* * * * * * * *

While a complete treatment of the durability of concrete would embrace within its scope all of the agencies and conditions which add to or take away from the permanence of concrete, we shall confine ourselves to one aspect of the subject, the deterioration of concrete under the action of alkali waters. Although we have limited the location to Western Canada, we consider that it lies within the province of this paper in its preliminary capacity to travel far afield; to ascertain what has been done by those who have been confronted with the same problem, and to profit by their investigations.

The subject is not new; we find mention of a paper upon the action of alkali on cement written for the Engineering News, of New York, in 1891. In 1910, instances of serious deterioration of concrete in the sewers at Great Falls, Montana, came to light. The Montana Agricultural College made a series of experiments to determine the results of the action of alkali salts upon cement, and the U.S. Bureau of Standards at the same time began an investigation of the action of salt in alkali waters on cements.

That the phenomenon of the deterioration of concrete in Western Canada is widespread and of sufficient magnitude to warrant the expense of a thorough investigation is evident from the following brief review of failures reported up to date:—

In the province of Manitoba, in and around Winnipeg, there are serious failures to report. In the foundations of the Grain Exchange the deterioration had gone so far as to have involved the replacing of all of the concrete footings at no inconsiderable expense. In the foundations of the Union Bank, where alkali ground water was present, there was deterioration. Further evidence of serious deterioration has been found in the sewers of Winnipeg and St. Boniface. While we have referred to these cases as alkali failures, we are not prepared to offer them in evidence as examples of the action of alkali salts upon well-made concrete. While on the Grain Exchange there was conclusive evidence of lack of care in the grading and handling of the materials, in the cases of the sewers referred to we are not justified in offering an opinion from the evidence at hand.

Although we have received reports of but two failures in Saskatchewan, we feel that a further investigation may bring to light more evidence regarding this evil. Ordinarily, the deterioration is found at or below the ground line; in the rear of retaining walls or basement walls or in sewers; in all cases it is not apparent to the casual observer, and it requires either an actual failure or a careful investigation to disclose the evil.

In Regina, an instance of deterioration at the haunch of a concrete arch bridge has been reported. In Saskatoon, a basement wall was uncovered, bringing to light serious disintegration. While the ultimate cause of failure was the action of the alkali salts, we have no evidence to offer regarding the primary cause.

In Alberta, the evil has assumed proportions of sufficient magnitude to have warranted the appropriation of $4,000 to begin an investigation to ascertain the most efficacious method of combatting the evil. In many parts of the irrigation belt the concrete in wing walls and foundations which has been in place but a few years has completely disintegrated. From Calgary we have reports of deterioration of sewers with evidences of alkali as a contributory cause. Here again we must offer the facts of the failure with no evidence of the primary cause. I might note in passing that engineers in Alberta who strive to obtain a well-prepared concrete, labor under the great disadvantage of being unable to obtain a well-graded, clean sand. The different kinds of sand available, whether bank run or screened, will run uniformly fine with a high percentage of silt. How serious is this handicap may be inferred from the fact that the aggregate for concrete used in the eastern edge of the irrigation belt was hauled eighty miles from a pit near Calgary. Because a large part of the concrete which has been placed in Alberta without engineering supervision has been made from a bank run aggregate, poorly graded and not washed, we may anticipate deterioration where this concrete shall chance to come within the sphere of activity of alkali salts.

Summing up the above, we find ourselves conclusive evidence of deterioration of concrete in the presence of alkali salts in Manitoba and Alberta and an outline of a case in Saskatchewan.

The phenomena accompanying the action of the salts of alkali water upon concrete are the withdrawal of the lime content from the cement with a complete loss of the binding power which the cement had possessed. The lime combines with the SO_4 content of the alkali salt to form a new substance which, instead of binding the aggregate together, requires more space than the lime in its original form, thereby tending to force the aggregate apart. In the case of the deterioration on the Grain Exchange, all cohesion had been lost and one might easily have removed the stones of the aggregate by hand.

Because of the fact that concrete is a building material upon which the engineers of this region have placed the stamp of approval, and because a disease of concrete of serious proportions has developed, it is incumbent upon the engineering fraternity to know the characteristics

*Paper read before the Manitoba Branch of the Canadian Society of Civil Engineers.

peculiar to this disease, and the conditions under which it flourishes; to ascertain what means may be employed to prevent the disease, and not only to make use of these means, but to spread the knowledge acquired throughout the entire field of concrete activity.

While entering upon this investigation with open minds, we are aware of a widespread conviction among engineers that a well-proportioned, properly placed concrete will resist the action of the salts of alkali water, and that acting under this conviction engineers have designed and installed concrete structures involving large expenditures of money, having created in the minds of their employers the presumption that concrete was a permanent building material. It is, then, the object of this investigation to determine whether it is possible and economical, with the materials at our disposal and with the exercise of due care in the handling of these materials, to produce a concrete which will resist the action of the alkali waters or whether it is either necessary or even conservative in the light of present knowledge to recommend the use of a waterproofing coat for concrete in places where alkaline salts are present.

Alkali is a term used to designate the soluble salts that accumulate in regions of little rainfall. They are formed by the disintegration of rocks and are found in the soils as well as in the drainage water which leaches them from the soils. The sulphates of magnesium, sodium and calcium are the best-known of these, which together with the chlorides are the most active agents for the disintegration of concrete.

Investigations have been confined for the most part to the action of either individual salts or several of the salts combined in solution upon cement or upon cement mortar. Having determined that the disintegration of the concrete under the action of alkali waters was due to the action of the salts upon the cement content of the concrete, investigators have observed the action of concentrated solutions of alkali waters upon cement and cement mortars, with a view to concluding from the results of the tests the probable action of the alkali upon porous concrete. Series of tests based upon this assumption have been conducted at the University of Montana, the University of Wyoming, and the University of Colorado. A most comprehensive series of tests was made by the U.S. Bureau of Standards, the results of which are embodied in a complete report issued in 1912. We are not concerned at this time with the details of these reports only insofar as we may conclude that they have established certain definite hypotheses which need no further proof, and from which we may proceed as a starting point for future investigation.

We have concluded, after a careful perusal of the information offered in the various reports of the tests showing the action of alkali water upon cements, that we are in agreement with the authors of all of the reports in the conviction, *viz.*, that alkali waters, if allowed to permeate through masses of concrete, will cause ultimately complete deterioration of the concrete. The instances of failure already adduced in the different provinces of Western Canada offer further convincing evidence in support of this conclusion.

We may then logically confine our activities to an investigation of the action of alkali waters upon a well-made and well-proportioned concrete with a dense, non-porous surface. The only experimental evidence which we have obtained upon this aspect of the subject was found in a report of the U.S. Bureau of Standards, dated November, 1917.

A series of concrete blocks of a selected aggregate in the proportions of 1 : 1½ : 3 and 1 : 2½ : 5 were made at a central laboratory, and after curing were placed on eight different projects in the alkali region of the United States, extending from the northern boundary to the Rio Grande. These blocks were placed in the soil at locations where the ground waters were known to contain alkali salts, and where the concrete would be freely exposed to the action of the alkali waters. Other concrete blocks of the same proportions, 1 : 1½ : 3 and 1 : 2½ : 5, were made from the aggregates obtainable at the various projects, and in common use in the various localities as ingredients for concrete. While these blocks were carefully moulded, no mechanical grading for maximum density was attempted. These blocks were exposed at the same locations with those containing the selected aggregate.

In this way an opportunity was afforded not only of comparing the action of the salts upon well-proportioned and well-made concretes, with varying mortar contents, *i.e.*, 1 : 1½ : 3 against 1 : 2½ : 5, but also of comparing the scientifically prepared concrete, with that brand which would be held in each locality, in the common acceptation of the term, as "good concrete."

The report contains observations made after one year's exposure. There has been no evidence of disintegration in those blocks made from the selected aggregate in the proportion of 1 : 1½ : 3. Of the blocks made from the selected aggregate in the proportion of 1 : 2½ : 5, four out of a total of thirty blocks have shown indications of disintegration. While the comparison based upon the above evidence is in favor of the 1 : 1½ : 3 as against the 1 : 2½ : 5, we do not feel that the evidence is complete enough to warrant us in drawing a conclusion.

Reverting now to the blocks made from the local aggregates—on two of the projects, all of the blocks of both proportions have shown indications of alkali deterioration. Of the blocks prepared in the proportion of 1 : 1½ : 3, ten out of thirty-two blocks (about one-third of the total number) have given evidence of deterioration, while eighteen out of thirty-two of the 1 : 2½ : 5 blocks (almost two-thirds of the total number) have shown signs of failure.

From these tests we may reasonably conclude that it is conservative to assume that concrete made from local aggregates without mechanical grading, may be porous and liable to disintegration in the presence of alkali waters. While not warranted in drawing a conclusion regarding the comparative resistance to deterioration offered by concretes with varying proportions of mortar, we feel justified in calling attention to the preponderance of evidence in favor of the concrete with the higher cement content.

From the evidence presented in this report, we can offer no conclusion regarding the ultimate effect of the action of the salts on the concrete made from the selected aggregate, because the time allowed for possible deterioration covered a period of only one year. We have no further experimental evidence to report upon this phase of the subject.

In the absence of direct and definite evidence upon the subject it may be profitable to consider indirect evidence which, though not of itself able to produce conviction, yet may be of sufficient value to confirm a conclusion already suggested. Under this category there may be adduced an argument drawn from the fact that there has been an opinion held in common by the engineering world that well-proportioned, properly made concrete will resist the action of alkali waters. Such an opinion widely held throws the burden of proof upon an objector, and establishes a presumption that the opinion has some basis in fact.

In support of this presumption, we may offer the following contentions: First, the fact that, although in alkali regions, there are many evidences of the failure of concrete, yet there are many concrete structures in the same regions exposed under similar conditions which have given no signs of deterioration. Many have drawn the conclusion that if some concretes have survived the assaults of the alkali waters, then the failures of other concretes must have been due either to improper grading of the aggregate or to a careless mixing and molding of the concrete.

Further confirmation of the widely held opinion that good concrete will resist the action of alkali waters has been based upon the known facts regarding the action of the salts of sea-water upon concrete. The active salts in sea-water are the same as those in alkali waters, namely, the sulphates and chlorides of magnesium and sodium. While innumerable instances of failures of concrete in sea-water can be adduced, there are many piers and walls in salt water which have been in service for many years, and which are intact, showing no evidence of deterioration.

The scientific basis for the assumption rests upon the contention that in a well-proportioned, properly made concrete, the calcium content of the cement at the surface exposed to the air, combines with the CO_2 of the atmosphere to form calcium carbonate, a salt which is practically insoluble in the presence of alkali salts. While it may be contended that calcium carbonate is soluble in sodium chloride, the fact remains that the carbonate surface of concrete in salt water, when not removed by mechanical abrasion, will withstand the action of the sodium chloride of the sea-water. According to this theory, then, a dense non-porous skin of calcium carbonate is formed on the surface of good concrete; and upon the integrity of this surface depends the life of the concrete.

This is a brief statement of the indirect evidence bearing upon this phase of the subject. Inasmuch as the direct and indirect evidence combined lead to no definite conclusions, further investigations are needed.

The details of the plan to be adopted in an investigation are a matter for individual opinion, and I will take this opportunity of outlining a *modus operandi*. Locations in the western provinces in which it is evident that alkali salts are present in the ground water, should be designated. At these locations concrete blocks should be placed in the soil exposed to the action of the alkali waters. At each location the blocks should be of three kinds:—

First, blocks molded under the supervision of an engineer in the proportion of one part of cement to five or six parts of the combined aggregate obtainable in the district, the parts of the sand and gravel to be so proportioned as to give a concrete of a maximum density for the given cement content and the concrete to be placed with as small an amount of mixing water as will allow of being properly worked.

Secondly, a set of blocks should be made by a local contractor from the same aggregate in the proportion of 1:2:4 and of the consistency which is the common practice in the locality. These blocks should be fair samples of the concrete used in that district.

Thirdly, a set of blocks of a leaner mix and with the various blocks protected with different waterproofing coats should be exposed under the same conditions. Observations made at intervals of a year should be recorded, passed upon by a committee, and published.

The objects aimed at in this plan are to ascertain, first, whether a well-made concrete, proportioned from local aggregates in a manner which is commercially practicable for both large and small jobs, will resist the action of the alkali ground waters which are present; and second, whether the ordinary commercial concrete obtainable without engineering supervision, will withstand alkali salts.

Should these experiments show that one or both classes of concrete will deteriorate, then it may be necessary to recommend the use of a waterproofing coating, and the experiments with the third class of blocks will offer evidence upon which to base recommendations, as to the kind of waterproofing to be employed.

It may be pertinent at this time to revert to the fact that while the information from an investigation may not be available for several years, we are confronted with our immediate problem of the position which engineers should assume in the light of our present knowledge or lack of knowledge.

We have been forced to the conclusion that a porous concrete will disintegrate under the action of alkali salts. Engineers are familiar with the methods to be adopted in the attainment of a dense, non-porous concrete, and they know, too, that care in every operation of the making of the concrete is the price of success. Yet it is common knowledge that a large proportion of the concrete in the western provinces has been placed either with inadequate engineering supervision or with no supervision at all. The natural results of such a policy has been the wide-spread opinion held among contractors, foremen and laborers that concrete is a fool-proof material and that special care in the making of the concrete is not necessary. Reliable knowledge of the effect upon the density and compressive strength of concrete, of varying the proportions of cement, sand, gravel, the amount of water, the method and time of mixing, and the method of placing,—such knowledge is rare among foremen, workmen and even among subordinates employed by architects and engineers to supervise the work.

Under these conditions it is reasonable to suppose that much of the concrete placed in foundation work has been of a porous quality, and we may anticipate reports of failures when such concrete comes within the sphere of action of alkali waters.

The conservative position, then, for the engineer who is responsible for the placing of concrete in foundation and sub-soil work, should entail the examination of the soil and ground water for alkali salts; careful supervision of the proportioning and handling of the material to give a dense concrete, with a non-porous surface; and an adequate provision for the removal or drainage of the ground water.

In conclusion, we wish to apologize again for having been unable in the time and with the means at our disposal, to obtain more convincing evidence on this subject. We are painfully aware that we have offered in evidence only one series of facts which should have a place in a paper upon the durability of concrete in Western Canada, namely, the announcement of failures of concrete in the various provinces; and that the body of this paper has been built up from evidence dealing with conditions prevailing outside of the Dominion, which we have assumed as on a par with those which prevail in Western Canada. May we not offer this confession of our inability to obtain necessary information upon this important subject, as an argument in favor of an early beginning of a complete investigation into the action of the salts of alkali waters upon concrete?

The 14th convention of the American Concrete Institute will be held at the Hotel Traymore, Atlantic City, N.J., June 27th, 28th and 29th, 1918. This convention had been arranged for February, but owing to the unusual traffic conditions at that time, was deferred until the later date.

ENGINEERING PRESTIGE

(Continued from page 332)

The question of public ownership of various utilities is one of importance. The branch could doubtless do much to clarify the situation and to show the public the merits and demerits of public ownership.

There are, doubtless, opportunities in connection with the food and fuel problems which we might help to solve.

We could study the subject of producing denatured alcohol for industrial and power purposes.

The question of how to prepare for post-bellum days is of paramount importance from the social, commercial and national points of view.

Problems of transportation, town planning, natural resources, engineering projects, industries and developments, taxation, and many other matters are capable of exhaustive treatment by the branch, and these intimately concern the community.

It might be possible to arrange a bursary for a poor lad to pass through the university, by the assistance of the branch.

Publicity

One important feature in the relation between the branch and the community is concerned with the matter of publicity. Our meetings generally are held privately, attended by members only, and not much information is given to the daily press with respect to what is being done. There are, of course, exceptions, but they are recent and rare.

Cleveland, Providence, Rochester, Philadelphia, Ottawa and other societies have recognized methods of gaining publicity in the daily papers. Some also arrange for public lantern lectures on engineering works for schools, libraries, churches, societies, etc., with a view to instructing and educating the people in matters which are of importance to them. Some societies have done a great amount of work in this direction, Cleveland being a prominent example.

The American Association of Engineers, which was established in June, 1915, and has nearly 3,000 members, "goes into publicity because it believes that engineers as a whole will be benefitted to the extend that the public knows about their work already performed or of the position largely achieved which can be realized when the public really understands what can be gained in greater health, comfort and prosperity."

Dr. J. A. L. Waddell says: "To secure greater recognition (which is tantamount to increased prestige and influence) requires that a more extended publicity be given to the work of engineers and to the results and effects thereof upon the community in which those works exist. It is not sufficient merely to describe the technical details of a structure or other piece of construction work; but it should be shown how such a structure or construction affects the community, by drawing a sharp contrast between the conditions preceding the improvements and those subsequent thereto. It is thus that the public can best understand and appreciate."

This is now partially done by the newspapers, and it is appreciated by the public and the engineering profession, but it requires a persistent, consistent and organized publicity to "establish our profession in its rightful position of leadership by educating public opinion."

Certain daily newspapers make engineering a special feature of certain issues, and publish articles of undoubted merit and originality. Others, again, have occasional items, prepared for popular consumption, but these are often inaccurate and misleading. The description of the expansion and contraction of the Quebec Bridge is a recent example. The profession welcomes the services rendered by the press, and we feel sure it would give every assistance to newspaper representatives if the opportunity was afforded. Engineers are not always absorbed in the technicalities of their work; they are often able to give ideas. In fact, they have always to organize in advance, and are compelled to be visionary in a practical sense of the word. They have to see ahead and prepare. Who, then, can furnish more abundantly ideas for the communities to aspire to realize?

Gardner S. Williams, a prominent engineer in the United States, recently stated that "the man who conceives, who dreams the dream, is of vastly more importance and value to the world than he who merely makes it a reality. It is ideas that are needed—there are plenty who are ready to execute them. So the greatest in engineering are the designers, those who conceive and produce that which has not been conceived or produced before. The time has come when recognition must be given both to the dreamer and to the builder. Those who have made possible the present condition of human existence, upon whom the world depends for its morning meal and its evening light, for its daily news and its weekly bath, are entitled to the acknowledgment of the debt their fellows owe, and they must get it."

Engineers can become less prosaic and more imaginative and they can succeed in gripping the imagination and appreciation of the public by means of judicious publicity.

W. F. Tye said, "One of the attributes of a great people is to have a thorough belief in themselves." He might have said that the other is to impress this fact on the public mind.

Relation of the Branch to Its Members

The other phase of the question which we are asked to consider is the relation of the branch to the members. The estimation of the prestige and influence of the Branch in the minds of the members is one of great importance, because, while the branch may survive in the absence of a general public recognition, it cannot live long if the members are not satisfied. At any rate, its existence would be that of languor and emasculation if its prestige and influence were inappreciable.

It will be observed that four out of the five objects of the Engineering Institute of Canada, and therefore of the branch, are primarily personal in their significance. We have already dealt with the fifth object, namely, the relation of the profession to the public.

Prestige and influence of the branch are ultimately associated with each of the objects and we will endeavor to present our ideas in connection with each of them.

To facilitate the acquirement and interchange of professional knowledge among its members is a very important function of the Institute, and when fully developed, affords the members an excellent scope for service.

The brotherhood or masonic sentiment of placing the knowledge and experience gained at the disposal of others, should be cultivated, and furthermore, it is even more important that the members should take a greater part in the discussions and papers than has hitherto been the case; it offers an excellent opportunity of enforced study to correct deficiencies. Those who are seeking information should not be reluctant to make enquiries, and those who are in the fortunate position of being able to impart information should be generous in giving it. Free discussions and candid criticisms have made other engineering organizations of greater value to their members. It may be affirmed generally that the value of a paper and

its discussion may be measured by the information imparted. Discussions may be made to be more valuable than the paper; indeed, one of the functions of reading a paper may be asserted to be to induce the members to openly discuss and criticize and to add to the information given. If members will invest their knowledge and experience for the promotion of the prestige and influence of the branch, they will eventually earn a dividend in the form of mutual esteem, and this is worthy of a considerable effort and sacrifice.

A succession of papers, however excellent in quality, by few members will not bear fruit unless the many are prepared to contribute to the fund of knowledge. Problems are seldom solved by different engineers in an identical manner; each member has some individuality in his solution; varied conditions require different treatment or engineering becomes stereotyped; new and valuable developments are the product of circumstances as necessity is the mother of invention, and the discussion of papers affords the engineer abundant and excellent opportunities to present information of this character. The branch can develop this feature, and when it attains this object to the full, its prestige and influence will be advanced to an extent which will doubtless exceed our sanguine expectations.

The presentation of medals, premiums or other awards to members for papers is appreciated, and the subject should be considered by the branch.

The number of subjects which we could discuss with advantage is great, and we invite members to consider the following as possible ones for papers:—

The essentials of specifications; economics of bridges; rainfall and engineering; city acquisition of Toronto street railway; Toronto harbor works; Toronto's new union depot; high or low railway approaches in Toronto; activated sludge process of sewage treatment; city transportation problems; city planning; aesthetic treatment of structures; problems in local improvement assessments; research in its relation to engineering; engineering and food production; valuations; engineers and conservation of life; indexing and filing of records; statutory registration of engineers; local government board for Ontario.

The prestige and influence of the branch in the minds of its members can, of course, be materially promoted by holding meetings which are both instructive, attractive and fraternal. Our meetings cannot be said to be well attended. One member, in reply to the question, stated that "if each member would consider it his duty as well as his privilege to attend all meetings of the branch, a healthy interest would soon be developed." Another replied suggesting "more meetings. We do not see fellow-members often enough to really know them or become interested in meeting them."

The following are the other remarks as to the work of the branch:—

"That papers, studies, etc., of the Institute deal with the commercial and economic features of engineering work."

"A better and printed programme, with regular meetings."

"Development of social side."

"Greater usefulness to younger members."

"Papers given before the Institute should have particularly technical parts eliminated so that members in other branches of the profession could still follow and appreciate the paper."

"Would like to see the Institute the place of open and instructive discussion of engineering problems."

"It would be well to affiliate with the American Society of Civil Engineers, if possible."

"There is need of vim and action."

"Regular dates for meetings, programmes of meetings planned further ahead, and more attention paid to securing local talent."

"Strongly advise close co-operation between American and Canadian Societies."

"All should join the Engineers' Club."

Sixteen replies offered suggestions as to the work of the branch.

The branch may be considered as the primary and vitalizing institution where members are given equal opportunities to serve and to be served and receive training for larger fields. The provincial division may be made the secondary institution where the experience and inspiration obtained at the branch would be given scope for increased development. The federal council should be the ultimate forum where those who have rendered signal service would find a vaster field for their energy, experience and knowledge. This is the vision which every member should have. This might be the policy of the Institute to foster. This might be made the dynamic influence to draw out the best we all possess. Reward or honor in proportion to service may not be in the minds of those who do their best, but all are human and like to know that what they do is appreciated.

"The duty of technical societies," said one engineer, "is to emphasize the qualities of sympathy, integrity and nobility in an engineer, entirely apart from any recognition of technical abilities."

The fraternal element might be mentioned in connection with visitors from other branches. It is highly desirable "to cultivate friendly relations with all engineers," and it would be an advantage if engineers visiting different cities where branches are located, would carry with them a card of introduction from their own branch, so that we might know them and extend to them our welcome. One of the chilling effects of attending meetings is to be unknown and isolated where we might be given a cordial fraternal reception if the members but know who we are. As Gardner S. Williams stated, the branches should be the very "embodiment of democracy." We are mutually concerned in the success of individual members, as is evidenced by the satisfaction felt by us in the distinction conferred upon men in various parts of the battle fronts.

To Promote Professional Interests

The Engineering Institute of Canada admits engineers engaged in any branch of engineering, and consequently it is anticipated that some day it will be in a position to speak for the whole profession. The attainment of this anticipation depends in a large measure upon the success of the branches, and sufficient power should be invested in them to make them the active and energizing unit of the Institute.

Professional interests comprise the status of engineers in the community, employment, compensation and brotherhood. We submit that each of these matters should be carefully considered by the branch. W. F. Tye, in an address before the Ottawa Branch in 1917, very ably discussed the subject of the present status of the engineer in Canada. He referred to the fact that we are seldom put in government commissions or consulted on technical matters by the government, even when the questions involve engineering problems.

Charles C. Garrard, in an article contributed January 25th, 1918, to "The Times Engineering Supplement," on the place of the profession, remarked that "on studying the function of the engineer, the first differentiation one can make is that he is a worker with his brain. It is a trite distinction to classify all workers into the two classes of manual and brain workers. Nevertheless, it is a true distinction, and one which must, by the nature of

things continue. Both classes of labor are necessary, and both should be organized so that not only may the interests of the individual members be safeguarded, but that the whole may use its corporate power to the best advantage. The tendency at the present day is for the manual workers to become better and better organized. On the other hand, with few exceptions, such as the medical and legal professions, the organization of brain workers is either totally lacking or wretchedly ineffective. In no profession is this more apparent than in engineering. Strong, and in many ways active, engineering professional institutions are in existence, but they do not take upon themselves responsibility in this matter, and the question arises whether they can be adapted to the desired end or whether new institutions or engineering associations are required. The latter course appears very undesirable, and the existing societies, if properly used, should be sufficient.

"In the past, engineering institutions in Britain have devoted themselves almost entirely to the academic side of the profession. In setting this high value upon their position as the repositories of engineering knowledge and tradition, the members of these societies have shown that they have been animated by high ideals. In suggesting, therefore, that new functions should be added to the existing ones, it is necessary to say that the high ideals hitherto obtaining need be in no degree abated. It is really only a question of making the ideals effective and making the institutions themselves such a power in the country, that in all engineering matters, scientific, industrial and financial, it will be just as much a matter of course for them to be consulted, as it is nowadays for the government to take into counsel the Engineering Employers' Federation, or the Amalgamated Society of Engineers."

The name "engineer" is doubtless productive of confusion in the public mind, because it means so much and yet so little. It connotes, for example, the person who plans and builds a railroad across a continent, or the person who operates the locomotive on that road. The name "engineer" may imply the person who designs and constructs any of the great water supply schemes, and also the person who puts in the plumbing in our houses. It may refer to the chief engineer of an immense hydro-electric undertaking and also the one who installs the wiring in a cottage. Men who design, operate and make pumps, dredges or heating plants, and they who designed and built the Quebec Bridge, as well as the men who turn swing bridges, are called engineers.

We have civil and military engineers and engineers of all the numerous branches of modern engineering, including agricultural, forest, efficiency and others. The divisions are so legionary and often so meaningless to the public that it is small wonder it frequently fails to appreciate what we are, or what we are doing, and in this manner our status is affected.

We each endeavor to specialize in some branch of our profession or work, and desire to be publicly known by a title which distinguishes us from others. And, moreover, we have separate, distinct and an increasing number of organizations to represent the several interests. There have been reasons for this, but the time has come for blending together to constitute one united and irresistible power. Engineers up to the present seem to be obsessed with the idea that individualistic attitude or condition of the sections of the profession is of advantage. The medical, legal and other professions do not have this idea. Each has its sections and yet recognizes and loyally support one great organization which is virile, powerful and respected.

The architects are able to command public recognition by virtue of their democratic and representative institution. The Chambers of Commerce represent every kind of competitive business, yet through the federated chambers they possess great influence. The Canadian Manufacturers' Association includes a great variety of competitive industries, and by setting aside individualistic idiosyncrasies are able by union to do great things. The Federations of Labor comprise members of all kinds, and by their united stand are able to sway national elections and to insist upon recognition.

But the engineer so far possesses no such compelling power. We observe traditional ideas and customs established decades ago, when conditions were very different from the present. It is to be hoped, nevertheless, that the new name, "Engineering Institute of Canada," with a new spirit and aspirations among its members, will create a forceful and inspiring *esprit de corps* that will weld all classes of engineers who are qualified into a body that shall be representative and in a position to speak in an unmistakable and authoritative manner in our behalf. If and when this occurs, the anomalies, confusions and weaknesses of the past will be forgotten, and by the creation of a homogeneous entity we shall be able to impress on the public that we are worthy of its highest esteem and of a status that shall be mutually beneficial.

"Let us, therefore, organize," writes L. G. Legrand, of Winnipeg, "for in organization is the secret of strength, the basis of influence and the opportunity for power." This is a consummation towards which the branch might devote its thoughts and energies in the immediate future, and thereby promote its own prestige and influence.

We observe by the technical press that the engineers in the United States are seeking to solve this identical problem through the Engineering Council, the American Association of Engineers and the Committee of Co-operation. Each of these is endeavoring to attain the same result in different ways. We would desire the Engineering Institute of Canada to be the one great dominating and influential engineering institution in Canada, representing all engineers, and by making the branches and divisions the real and effective bases of the organization, all matters which affect our interests can be attended to in their incipient stages, and also be prevented from becoming a source of menace to the profession generally.

Status of Engineers

There is, of course, another side to the question of the present status of engineers, and that is whether legislative powers should be secured to restrict the practice and the title of engineer to those who are qualified. The questionaire which was issued to the members, asked for expression of opinion on this matter. The result has virtually left no decided impressions as to what is the representative opinion with reference to the registration or licensing of engineers. About two hundred questionaires were issued and forty-eight replies were received. Of these, twenty-one members stated that they were in favor of licensing, nine were against, eight were undecided or conditionally favorable, and ten expressed no opinion.

We are somewhat disappointed with these results, because the members who responded relatively constitute but a small proportion, and may not be representative of the branch members.

There can be no doubt, however, that legislative restrictions are desired by a large section of the members of the Institute in Canada. Quebec and Manitoba have these

powers at present; Alberta appears to be anxious to obtain similar powers; British Columbia endeavored to have the legislature define the term, "engineer." This question has for some time been discussed in the United States. Indeed, some States have granted statutory authority to limit certain engineering practices, and engineering societies in others are committed to this policy.

The Calgary Branch suggests that legislation would follow out the spirit and intent of the Manitoba and Quebec Acts concerning engineers, and that it should be Dominion-wide and not provincial in its scope. If the British North America Act, however, does not make this feasible, then the acts passed by the various provinces should be made reciprocal. The experiences of the medical, legal and educational professions in this regard should afford us an excellent lesson as to the absurdity of making each province a water-tight compartment in these matters.

The Calgary Branch further suggests that the "gaining and maintaining of the necessary legal status to allow of practice, would necessitate the gaining and maintaining of registration as a member of the Engineering Institute of Canada. And in this connection there is suggested the one radical and new idea, that registration with the Institute could be gained only on the issuance of a certificate granted by a Board of Engineers which would be controlled by the science faculties of all the recognized universities in Canada, and not by the council of the Institute. And similarly, the grading of the registered members would be controlled by the Board of Engineers."

It must be presumed that engineers equipped with satisfactory credentials coming to Canada would be granted the necessary certificate by the Board of Engineers.

Some prominent engineers believe that licensing of engineers would be retrograde; others again believe that "proper standard requirements fixed by law which the engineer must attain to practice independently, must produce beneficial effects." (Engineering News Record, of New York, January 10th, 1918.)

"As far as the exclusion of undesirables from the practice of engineering is concerned, licensing would be a good move, but no state has any moral right to prevent non-resident engineers of ability from doing work within its boundaries without first passing an examination and paying a fee for a license." This is the view held by Dr. Waddell.

"Any land surveyor, locomotive driver or chauffeur, even," says Prof. William H. Burr, may call himself an engineer and the public as a whole will award him what he claims, while the members of the profession either do nothing or mildly criticize the procedure. There seems to be insufficient professional spirit to assert a proper dignity and secure such discriminating legislation as shall convey to the title its honest meaning or defend its use. Various attempts have been made to secure legislation which through a proper procedure of licensing would give to engineering the professional standing due to it, but the the members of the profession have not yet attained to a sufficiently broad and intelligent view of the matter to extend their vision beyond certain personal considerations and demand such measures as may protect and dignify the profession as a whole. The public is generally ready to accept at their own valuation any body of intelligent and honorable men, but if a body of even such men lack sufficient self-respect to assume and occupy worthily a professional plane and conduct their work in a suitable and professional manner, the public may hold them, even, cheap; and certainly will fail to accord the recognition properly desired and claimed by prominent and true members of the profession."

Under the present conditions it is difficult to discern how the Engineering Institute of Canada can obtain legislative limitations or to persuade parliament that the practice and title of engineers should be limited to those who are qualified, when the Institute only represents a portion of the engineers in Canada. The situation would change materially if the other sections of engineers were to join forces or, better still, to become members of the branches.

It is known to all that there are many engineers engaged in two or more branches of business. In fact, the different phases of engineering are so intertwined that it is difficult to demarcate their respective limits. The chemist and metallurgical engineer, the electrical engineer and the chemist, the analyst, biologist and sewage engineer are all closely associated. The mining engineer designs and constructs a variety of work, such as drainage, roads, railways, structures, bridges, water supply, heat, light and power, and so on; in short, as Dr. Raymond remarked, the mining engineer "has all the problems that torment the civil, mechanical and electrical engineers, together with a torturing lot of his own that they don't have."

These multitudes of inter-relations of the profession and the variety of functions which the engineers have to fulfil, afford the best arguments for union and for legal standing. The public is not adequately safeguarded; the absence of statutory definition and limitations place the public under a grevious disability. It knows that doctors and lawyers cannot practice without due qualifications, and yet when it requires an engineer to carry out works of vital importance, which in the aggregate involve vast expenditures and also involve the health, comfort, prosperity and life of the community concerned, the public has no statutory assurance that the person to be employed is duly qualified.

It must be remembered, however, that in some respects engineers are not situated similarly to doctors and lawyers. Comparatively few doctors and lawyers are officials or employes of others, but the majority of engineers are. The questionaire revealed this situation very emphatically. Out of the forty-eight replies, twelve are from private practitioners and thirty-six are from those who are employed by the governments, public bodies, railways and private firms.

Licensing of engineers, under these conditions, may be of importance to those who are practitioners, but only to a lesser degree to those who are otherwise employed. If licensing is to be enforced in a comprehensive manner, then it may be deemed by the public to resolve itself into a professional union, as trade unions are to craftsmen. Trade unions are vitally concerned with the question of the status, rights and responsibilities of its members and jealously watch that no infringement of its non-statutory rules take place, not only by these men but also by the employers. Should serious infringements occur and the union fails to have it rectified, it declares a strike. In this way many who are not concerned in the conflict are often seriously affected and sometimes the guilty parties suffer the least. Statutory limitation of engineers, however, would be safeguarded by penalties to be imposed by the court, and to obtain decisions, it would be necessary for the Institute to undertake legal proceedings, because the complainant may not be able, for obvious reasons, to assume the responsibility. This matter would necessarily have to be taken up by the branch, division or federal council, as obtains with the medical, legal and other professions, for its own protection.

If a powerful corporation or municipality should employ an engineer who has not fulfilled the statutory requirements, it might lead to a strenuous and costly litigation. We would be prosecuting the action in the interest of the profession, whilst the corporation or municipality would have equal reasons for their shareholders or ratepayers, but not the same conception of ideals to assuage the antipathy to the restriction. Aside from this possibility, the corporation or municipality might perhaps employ the engineer under another title. To circumvent this eventuality, it would be necessary to have a clear definition of what is an engineer. F. H. Peters, Calgary, in his article in *The Canadian Engineer*, February 14th, 1918, expressed the same thing when he stated that if the profession is to have a proper standing it must be one that is defined by the law of the land.

The opinion of a committee of the San Francisco Society of Civil Engineers is that "the licensing question is sure to face us sooner or later, and if we have no satisfactory definition (of engineer) and a classification of our own, we shall have one thrust upon us by those who frame the new statutes."

The State of Florida in May, 1917, passed an act for the examination and registration of "professional engineers" which defines the title "professional engineering" to mean any branch of the profession other than that of military engineer, and a comprehensive list of works is given. So far as we understand, it does not apply to subordinate engineers. This act was based to some extent upon a draft which was prepared by an American society of engineers.

Employment

Employment is, of course, an ever-present question for us all. But our national engineering societies have taken no active part in helping engineers in this direction. The payment of annual dues, and receiving in return the proceedings of the organization and attending the meetings when possible, is no doubt the prevailing idea among many, of the functions and value of the Institute.

Employment has been considered "a matter with which the Institution of Civil Engineers is not officially identified," although assistance is given when possible. A committee was appointed in July, 1916, by the American Society of Civil Engineers, which reported in 1917 that "there is in existence a general feeling that our society should in the future give systematic study to the practical matter of employment."

It would be desirable that this question of organizing some form of co-operative employment clearance and of exchanging reports between the branches should be carefully investigated.

"The future of the profession," according to Fraser S. Keith, "lies largely in how far it is willing to assist the individual member." This is one method.

Compensation

The question of compensation is one which is of importance to all members, especially under the prevailing and prospective conditions.

It is instructive to note that according to a petition sent to the U.S. Railway Wages Commission by the Engineering Council for increased pay for assistant engineers, it was stated that assistant railway engineers are paid less than twelve classes of non-technical men. The Engineering News-Record, of New York, in its March 7th, 1918, issue published the following schedule of monthly pay:—

Road passenger engineers and motormen	$176
Road freight enginemen and motormen	153
Road passenger conductors	152
Train despatchers and directors	$131
Road freight conductors	131
Yard enginemen and motormen	128
Yard conductors	113
Road passenger firemen and helpers	106
Gang and other foremen	97
Yard brakemen	95
Road freight firemen and helpers	94
Assistant engineers and draftsmen	93
M. W. and S. foremen	92

The American Association of Engineers also reported to the U.S. Railway Wages Commission on the question of salaries of technical men employed on railroads. The association stated that the average monthly rates were: Draughtsmen, $90; inspectors, $90; instrumentmen, $100; assistant and resident engineers, $125; division engineers, $150. In the circular it is mentioned that the chief engineer of the L.C. & C. Railway in 1839 stated that "two assistants of division to be selected by the resident engineer, their salaries $1,500 per annum each." The pay consequently has been stationary, whereas all else have mounted up seriously.

It is anticipated by some that if legislative powers were obtained to license or register engineers, compensation would be automatically improved. This may be realized, although it is not clear how the laws of supply and demand will be changed materially. We have services to sell and their value depends to a large extent upon the prevailing demand for them and the available supply. Services, like commodities, are valued according to circumstances.

We believe that if engineers must be licensed before they can be employed in any capacity, the number of men available would probably for a time be less, and their general abilities would be greater. In other words, the inefficient ones would be weeded out. Still, laws cannot be passed without some regard being paid to those already employed as engineers and to newcomers from other countries who are qualified to act. Consequently if licensing would tend to create a dearth of engineers, and as a consequence cause the pay to increase, the conditions would soon become known and the field would be attractive to others. We cannot help expressing the opinion that the principal way of improving the compensation of engineers is to unite as a body to raise the status and to promote the prestige and influence of the branch.

Compensation can usually be demanded by capable men notwithstanding competition, but it is necessary to make ourselves known by our capacity and attainments. This can be done by reading papers before the Institute, by contributing to the discussions, by participating in public affairs, by forcing ourselves to the attention of the public and by showing character and judgment. "A proper recognition is essential so that adequate compensation may follow," says Dr. Waddell.

Dr. C. R. Mann was appointed by five United States national engineering societies and the Carnegie Foundation to investigate the question of the education of engineers, and after seven years' study and exhaustive interchange of views, he found that out of 1,500 answers to inquiries, 87% of the engineers placed more value on character, judgment, efficiency and understanding of men, than on knowledge and fundamentals and technique of practice. This verifies the old and self-evident thesis, that man is greater than his knowledge. In this connection Dr. Mann maintains that "the engineering profession can render no greater service to education than by constantly reminding the schools that the development of character, judgment and human sympathy is the ultimate end and aim of education."

Sir Maurice Fitzmaurice, in his presidential address, remarked that "the capacity of getting on with people and still holding one's own has a distinct money value and a very high one."

Defence

It is important for the prestige and influence of the branch that it should as far as possible support its members when it considers they are unjustly assailed. The reputation of the profession is vitally concerned in that of its members; the two are inseparable. The by-laws of the Institute provide for the disciplining of members who have broken any code of ethics, but it contains no provision for the defence of members who are unjustifiably attacked. The first implies the second, or one object of the Institute has been overlooked.

This function of an organization involves very careful consideration and a rigorous investigation, otherwise what at first may appear unwarranted, on full study, may be found to be the result of indiscretion or lack of judgment on the part of the members involved. But notwithstanding this element of uncertainty, it is desirable that the member may know that when the facts are proved to the satisfaction of the branch, he can rely on its support in time of trial. These cases usually occur in municipal engineering where the personnel of the council changes and influences are brought to bear to carry out certain schemes which the engineer sometimes cannot approve. As an official he should carry out the instructions of his council, but as its technical adviser he should justify his actions; therefore, the dual duties may occasionally place him in a predicament and open to attack. The fact that there is a branch which is prepared to support him may have no weight with the council, but it will afford him some assistance in doing what he deems to be right and proper.

The Calgary Branch stood behind the city engineer who was severely criticized in connection with the construction of the Centre Street bridge, and proved to the public that his critics were unjust. Both the engineer and the branch gained respect and prestige by this action.

Research

One of the objects of the Institute is to encourage research, and especially as the Institute is to represent every branch of the engineering profession there should be some scope. Alfred Saxon stated in Manchester (1917) that "inasmuch as mechanical engineering was the key industry to all the industries, the need of scientific research to assist in the creation of new ideas and new methods and to reduce manufacturing cost and prevent waste of material, was overwhelming."

Albert H. Hooke remarked, in 1916, that when the tunnel was being driven in 1891 in connection with the Niagara Water Power Works, aluminum, carborundum, alundum, silicon, artificial graphite, calcium carbide, cyanamide, etc., were unknown to commerce.

Engineers have not been absent from the field of research, for circumstances have often compelled them to make scientific investigations with the view to carrying out various projects with increased success and profit.

The use of coal and waste gases for different purposes, the generation and use of steam, the extraordinary development of the internal combustion engines, the uses of electricity, the development of water power, the application of reinforced concrete, transportation, electric communications, steel production, etc., are the products of creative engineering geniuses that have vibrated the world. Notwithstanding the enormous strides made in the recent past, the future holds out an invitation for greater conquests of natural forces and for their conservation for the use of mankind. The encouragement of research by the branch would help to increase its usefulness, and if it should lead to the discovery of a Bessemer, Ericson, Faraday or Edison, prestige and influence would be gained.

Benevolence

We might refer to the matter of benevolence in connection with branch activities. Misfortune comes to some when they are least prepared. The war has upset the careers of many, and although unemployment may not at present be a pressing matter, still some experience difficulty in finding it. Unemployment, sickness, accidents and other misfortunes are depressing events, especially when friends are few and funds are scarce. The prestige and influence of the branch would be exalted in such circumstances, if it were able to render assistance when needed. It is a difficult problem and a delicate one, especially in the cases of those whose temperament is such that they would spurn charity. Still, if we could render aid in a quiet and private manner, it would tend to alleviate anxiety, reduce the load and brighten the prospects of some fellow engineer in distress. The fact that we know of no such case may be due to the silence of the members and the absence of branch funds, but that they will occur is as certain as anything human can be. The raising of a fund for this purpose is relatively a small matter, as it can be done in various ways.

Conclusion

In presenting the foregoing report on "how to increase the prestige and influence of the branch," we have to state that the subject is opportune and important. The branch should be the cultivated sense of the body politic. It is the principal means by which we can assert our rights, enjoy our privileges and increase our professional standing. Neglect the functions and atrophy sets in; cultivate them and they develop in usefulness, strength and vitality.

We believe that the profession is destined to occupy a position of greater importance in the future life of the nation than it has ever done in the past, and that the era which is now unfolding its doors will call for loyal and efficient public service. Many of the troubles of the past have been prescribed for without making a scientific diagnosis of their causes, but in future the engineering profession will be invited,—nay, compelled,—to accept its duties and responsibilities in this work. The branch should constitute the strongest living organism of the Institute, otherwise our professional obligations and privileges will not be realized.

Engineers will be able to do a great amount of work as they are now represented, but when our forces are combined, the possibilities of doing greater work will be enormously enhanced. We would cherish the hope that engineers of all branches of the profession will see the force and influence of one great Canadian engineering organization. That does not mean the submerging of various categories of engineers, but the encouragement of the progress of each, under one common flag, one common aspiration and for one common achievement, namely, the promotion of the best in every branch of engineering for the advancement of our national prosperity; and this will assuredly redound to our personal and professional advantage, prestige and influence.

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Principal Contents of this Issue

DOUBLE-TRACK THE INTERCOLONIAL!

FROM Moncton to Halifax the Intercolonial Railway should be double-tracked as a war measure and as a measure of lasting importance to the prosperity of Canada. Halifax is a world port with wonderful possibilities, but it is being strangled by inadequate railway approach facilities. The Intercolonial, the Canadian Pacific (via St. John) and the National Transcontinental all pour Halifax freight into Moncton. From Moncton this freight must be hauled for 186 miles into Halifax over a single-track railway. The port of Halifax is now a big bottle with a very small neck.

On this continent the nearest port to England and France is Halifax. This is a factor of prime importance when bottoms are at such a premium and when the fight for world civilization may depend upon the ability of American and British shipping to survive the staying power of the Hun. The average freighter can save upwards of eight days in a return trip across the Atlantic if she sails from Halifax instead of from Portland, Boston or New York; and upwards of four days if instead of from St. John. That means that a boat on the Halifax route can carry from one-quarter to one-third more men, food, ammunition and supplies than can a boat of similar size which loads at American ports.

Railway transportation and port facilities govern the degree to which this geographical advantage can be utilized. The magnificent harbor at Halifax is rivaled by few in the shipping world. As the government's terminal plans mature at Halifax, that port will no doubt be equipped with facilities of first class, but railway congestion will still drive traffic into other channels unless the Intercolonial from Moncton to Halifax be double-tracked.

Operating officials state that a single-track railway can operate little more than 400 freight cars per day in each direction from any terminal, allowing for efficient passenger operation at the same time. About that many cars go into and leave Halifax daily, and probably more than that number are handled at St. John, but thousands of cars from the Canadian West and Western United States, now routed to American ports, would go to Halifax if the Canadian Government Railways could handle them.

The railways to the American ports are heavily congested. The whole shipping problem on the Atlantic coast would be materially relieved by widening the neck of the Halifax bottle. The Canadian Government Railways could no doubt handle from three to four times the present volume of traffic at Halifax were the line double-tracked from Moncton. Such an outlet for another eight or twelve hundred cars daily would not only relieve traffic congestion, but also, for the reasons outlined above, would be equivalent to a substantial increase in the number of freighters and transports under the Allied flags. The cost of this double-tracking would probably not exceed $12,000,000. It should be voted from the funds of the last Victory Loan, without hesitation and without delay, at the present session of Parliament.

GOVERNMENT OFFICE BUILDING

TENDERS are now being called by the Public Works Department for the construction in Ottawa of a nine-story office building which is being opposed by some Ottawa engineers and architects upon the ground that it does not conform with the excellent plan completed two years ago by the Federal Plan Commission, and that it will only anchor permanently what is now but the temporary inconvenience of the scattered location of war-time department overflows.

The government has been urged to adhere to the principles of the Federal District plan, and to construct this $1,500,000 building on government property in such location as to conform with the plan. There being no accepted or determined architectural design for the large group or main scheme of department buildings, it has been suggested that for the present only the steel and concrete be erected and fitted with factory sash, the outer shell of decorative stone to be added later when more funds are available and when the whole group of buildings has been finally designed. It has been said that this would permit at a minimum cost of a thoroughly hygienic and economical building, with all heating, ventilating and other equipment permanently in place.

In reply to an enquiry from *The Canadian Engineer* whether the government had given consideration to the Federal District plan in designing this building, Hon. Frank B. Carvell, Minister of Public Works, writes:—

"We have considered the Federal District plan for Ottawa very carefully, and the construction of the proposed office building in no way interferes with the suggestions therein provided for. The plan, so far as the government was concerned, practically made a suggestion as to what should be done on the north side of Wellington Street. The government of Canada is to-day paying $650,000 annually to the landlords of Ottawa, some of these rentals being on a fair basis and others amounting to little short of extortion. The war has brought an enormous influx of new officials to the service, and the Public Works Department is practically at its wits' end to find accommodation for them. Were we to commence the construction of a building on the general plan and along any plan which would be commensurate with buildings of that nature from an architectural standpoint, it would take two and a half to three years to get any unit ready for occupation, at a cost of 100 per cent. above normal and probably with an office capacity of not more

than 60 per cent. of that which we could furnish on the proposed scheme.

"We, therefore, decided to build south of Wellington Street between Albert and Queen, in a central location, an ordinary nine-story office building, which, we believe, could be completed by the 1st of July, 1919, and, while it would cost more than it would in peace times, yet, if the architects could get down to earth and design an ordinary business building, we estimate that we would obtain about 140,000 square feet of office space at a cost, including everything, not exceeding 70 cents per foot. The erection of this building in no way interferes with the city of Ottawa."

The report of the Federal Plan Commission was summarized in our issue of April 20th, 1916. The members of the commission were Sir Herbert Holt, chairman; Sir Alexander Lacoste, K.C., of Montreal; Frank Darling, of Toronto; R. Home Smith, of Toronto; and the mayors of Ottawa and Hull. The commission selected E. H. Bennett, of Chicago, as town planning expert, and E. L. Cousins, general manager of the Toronto Harbor Commission, as chief engineer. A number of assistant architects and engineers were engaged for a considerable period, and the cost of the plan is said to have approximated $70,000.

A public statement by Messrs. Cousins and Darling whether the proposed 700-room office building interferes with the Federal Plan or not, and if so, how seriously, would be timely and should be secured and published by Mr. Carvell. Their advice in this matter would appear to be almost invaluable.

ENGINEERING PRESTIGE

LAST year the executive of the Toronto Branch of the Canadian Society of Civil Engineers appointed a committee to investigate how the prestige and influence of the branch might be promoted. In this issue we publish the draft report written by the chairman of that committee. This report covers a great field for consideration. It refers to the part which was taken by engineers in the past and what will be expected of them in the future in connection with the immense business of reconstruction of the commercial, industrial, political and social organizations of the civilized world. The relation between the engineering societies and the public is dealt with in a comprehensive manner.

The personal phases of the problems which confront the branch, and indeed the whole of all engineering societies, demand serious attention. These include papers which might be read and discussed, the question of registration or licensing of engineers, organized bureaus for employment, rate of pay, benevolence and other matters of importance. These will all be discussed at a general meeting to be held soon, when resolutions will be submitted for the members to accept, reject or amend.

The questions which are reported upon do not pertain to the Toronto branch alone. They are common to all engineers in Canada. The information collected, the arguments presented and the criticisms offered should induce engineers throughout the country to take an active interest in the whole subject. Isolated action by the Toronto engineers will fizzle out like a squib in the dark unless other engineering bodies help to light the path.

Engineers should occupy the national position to which they are entitled, not only by virtue of their work and achievements, but also on account of the fact that the community depends upon them for almost everything that it enjoys. Lawyers have attained a national status of great importance, but the community could exist without lawyers. Without engineers it would soon starve, yet the engineers apparently do not hold the esteem of the public so fully as is their due.

We urge that this report, though long, be read by the engineers, and hope that the discussion at the meeting will lead to something tangible and beneficial.

PERSONALS

R. O. Wynne-Roberts has been appointed consulting engineer by Sault Ste. Marie, Ont., in connection with the construction of a new pumping station.

William Newman, naval architect and works manager of the Polson Iron Works and Steel Shipbuilding Co., Toronto, has resigned and is considering an offer from Hugh Mackenzie, of the United States Fleet Corporation, of Hog Island, Philadelphia, the largest shipbuilding company in the United States. During his connection with the Polson Company Mr. Newman, who received his early training with the Bertram Shipbuilding Co., of Toronto, supervised the launching of fifty-four vessels, all of steel construction, which is about one-half the total number of vessels of all kinds launched in Toronto during the past half-century. Probably the greatest shipbuilding feat supervised by Mr. Newman was accomplished a few years ago, when a 24-inch hydraulic dredge for government service in Hudson Bay was constructed in eighty-seven days. He also established a record when a lighter for service in the Hudson Bay district was constructed in thirty days.

Edward de V. Tompkins, M.Am.Soc.C.E., consulting and constructing engineer, who has for the past seven years had offices in the Professional Building, New York City, has moved to Chicago to take the general agency of the Cement-Gun Co., Inc., of Allentown, Pa., in charge of their mid-west territory. During the past twenty-five years Mr. Tompkins has designed and built many important water-front developments, including bulkheads, piers, power houses, factory buildings, conveyer systems, etc. He has also executed many contracts of magnitude for federal and municipal governments, including piers, bridges and sewers. He was bridge engineer of New York City for six years, and during the past administration was deputy commissioner of the Department of Docks and Ferries of that city. His previous commercial experience was as manager of the New York office of the Trussed Concrete Steel Co., manager of the Philadelphia office of the Columbian Fireproofing Co., and manager of the New York office of the Maine Electric Co.

ENGINEERS' CLUB SMOKER

About seventy members of the Engineers' Club of Toronto were present at the annual smoker, last Thursday, April 11th. Lieut.-Col. McKendrick related some of his experiences while at the front, especially road building. L. V. Rorke, president of the club, acted as chairman.

ENGINEERING INSTITUTE OF CANADA

Sir Herbert Ames' bill changing the name of the Canadian Society of Civil Engineers to "The Engineering Institute of Canada," was adopted last Friday by the Private Bills Committee of the House of Commons. The bill must now be approved by the Commons and by the Senate before the new name is officially adopted.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Reinforced Concrete Railway Trestle at Toronto

New Three-Track Structure Spans the Rosedale Ravine on the North Toronto Subdivision of the Canadian Pacific Railway—Premoulded Concrete T-Slabs Rest on Concrete Bents Supported on Concrete Spread Footings

By ARTHUR F. WELLS, B.A.Sc.,
of Wells & Gray, Ltd., Engineering-Contractors, Toronto

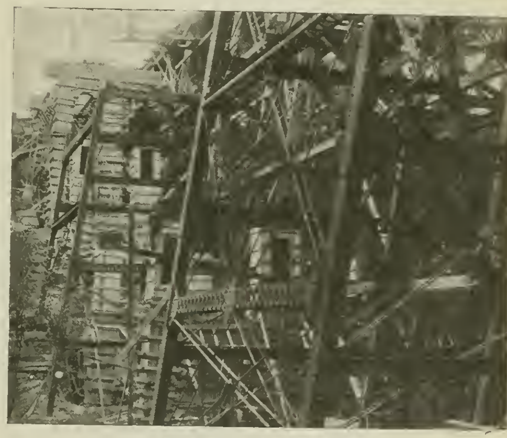
ABOUT one mile east of the Canadian Pacific Railway Company's station at North Toronto, a single track formerly crossed the Rosedale Ravine near Summerhill Avenue on a steel trestle. As traffic increased on this line, the trackage facilities became insufficient and it was decided to span the ravine at this point with a new, three-track trestle. In designing the structure for three tracks, provision was being made not only for present needs but also for a probable still greater increase of business over these lines in the comparatively near future.

In view of its location, it was necessary to give due consideration to the aesthetic features of the design of the new structure. The ravine to be spanned is a continuation southwards of Reservoir Park, and is largely used in the summer months by a great number of citizens as a resting place and recreation grounds. The utilitarian was therefore not the only consideration in choosing a suitable design and the present reinforced concrete structure seems more in harmony with its surroundings than the former steel structure.

A general plan and elevation of the trestle is shown in Fig. No. 1. The clear height from top of concrete foundation to base of rail is 82 ft. 7 ins. The length from face to face of ballast walls is 368 ft., and the width out to out of concrete coping blocks is 41 ft. The general design is concrete spread footings supporting concrete bents on which rest the premoulded concrete T-slabs.

Temporary Timber Trestle

The details of the foundation are shown in Fig. No. 4. The nature of the soil remains practically unchanged across the whole ravine bottom, and the creek is too small to require to be taken into consideration. The bearing value of the soil was determined by comprehensive tests, by means of tables and weights, at each end of each pier. The necessary spread of the footing was then calculated accordingly. Near the top of the footing, seven-eighths inch round reinforcing bars, placed longitudinally, distribute the stresses transmitted from the bent posts and give additional security against unequal settlement. One and one-eighth inch round anchor bars, eight feet long, bond the superstructure to the foundation. There are one hundred and twelve anchor bars in each pier.



First Concrete Bents and Part of Old Steel Trestle

The reinforcing bars are medium open-hearth steel. The concrete is mixed in the proportions of one part of Portland cement to two parts of washed sand to four parts of broken stone.

The bents of the superstructure are spaced alternately 34 ft. and 36 ft. Each bent consists of four posts braced by struts, as shown in detail in Fig. No. 3. The bents themselves are braced longitudinally in pairs. The reinforcing in the batter posts consists of twenty-four round bars varying in size from seven-eighths to one and one-

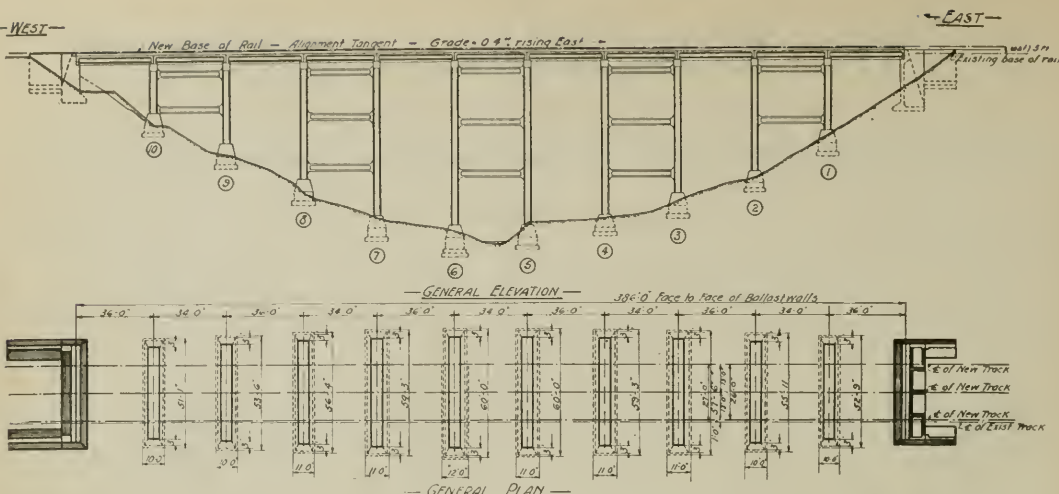


Fig. No. 1—General Plan and Elevation, C.P.R. Concrete Trestle

eighth inch. In the vertical posts the reinforcing consists of thirty-two bars of the same diameters. The outside post is battered one in twelve. All corners above ground are rounded off to a two-inch radius and the panelling of both posts and struts gives a particularly pleasing effect.

The ballast walls are each spaced thirty-six feet from the last bent and are of the standard retaining wall type.

The T-slabs which constitute the floor system were moulded on a site adjoining the railway track, a short distance east of the trestle. One concrete-mixing plant and special forms were used on this portion of the work exclusively. Referring to Fig. No. 2, it will be noted that in preparing the design, special attention was paid to the shearing stress in these slabs. Bent-up bars and stirrups, at comparatively close spacing, have been provided. These T-slabs are six feet high from bridge seat to base of rail. The outer slab carries an additional load of the coping blocks and the sidewalk brackets.

Pouring the Pre-moulded Concrete Slabs

The concrete throughout the entire superstructure is mixed in the proportion of one part of Portland cement, one and one-half parts of washed sand and three parts of broken stone. The reinforcing steel is placed as shown in detail in Figs. No. 2 and No. 3.

The deck of the trestle, consisting of the slabs described above grouted in place and anchored to the bents, is covered with a coat of waterproofing. This coat consists of one ply of waterproofing paper, lapped two inches; one ply of fifteen-pound bituminous felt, lapped two inches; two plies of unsaturated burlap, lapped half width; and one ply of bituminous felt, lapped two inches. All layers are mopped with bituminous cement, except the surfaces of contact with concrete slab or waterproof paper. The waterproofing is finished with a protective coat of three-quarters of an inch of mastic asphalt.

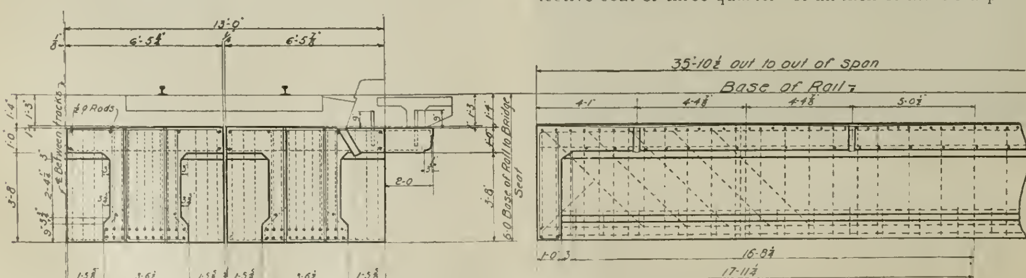


Fig. No. 2—Cross-Section and Longitudinal Section of Inner and Outer Slabs

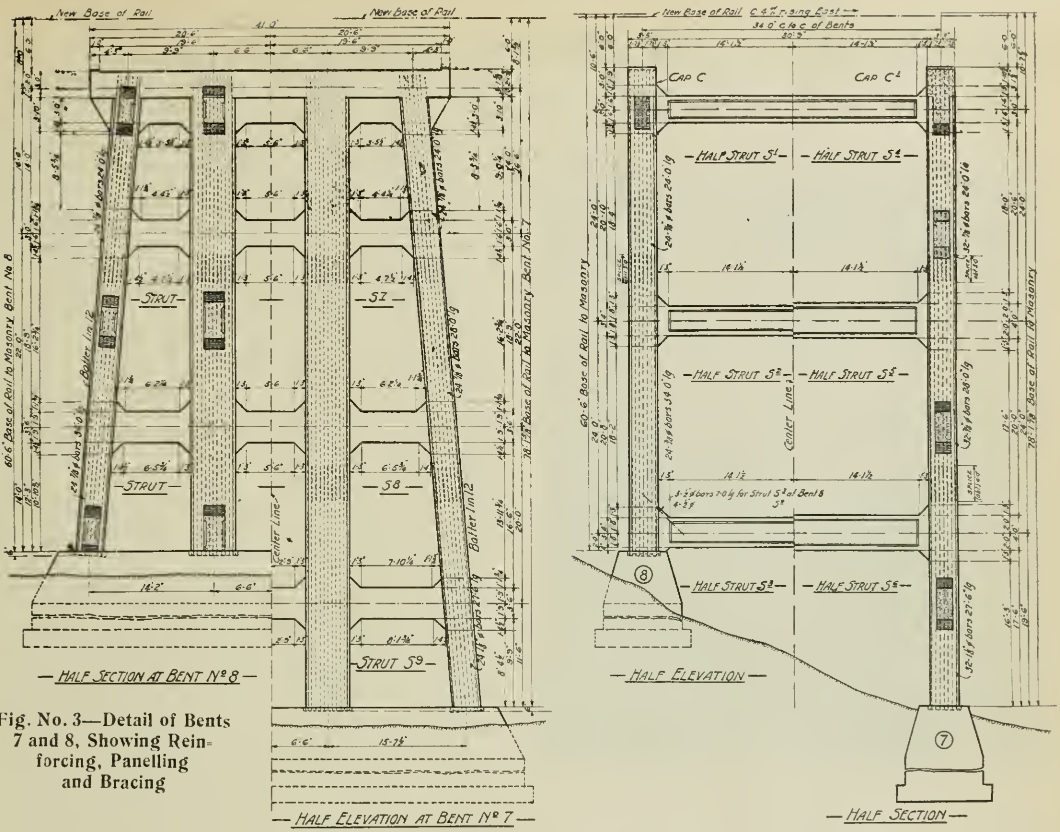


Fig. No. 3—Detail of Bents 7 and 8, Showing Reinforcing, Panelling and Bracing

The tracks are placed at thirteen-foot centres, and the ties are laid in broken-stone ballast. The axis of the bridge is east and west, and the alignment is all tangent, with a grade of 0.4 per cent. rising east.

The loadings for which the structure was designed were as follows:—

Dead load to consist of self weight of structure plus 500 lbs. per lineal foot of track, including rails, fastenings and ties.

Live load, Cooper's E-50 plus impact, the latter taken as 90 per cent. of $\frac{\text{L.L.} \times 300}{300 + y}$,

where L.L. = live load,
and y = loaded distance in feet.

Certain constructional difficulties were encountered during the carrying out of the work. It was necessary to erect a temporary wooden trestle so that single track traffic could be maintained across the ravine throughout the entire construction period. The old steel trestle was dismantled as the work on the new structure progressed.

One mixing plant was placed on each side of the ravine, and the concrete was carried to the forms in chutes. During freezing weather, double forms were placed around all concrete, and the intervening spaces were equipped with piping so that steam heat could be applied whenever necessary. The economy of construction consisted in being able to duplicate the use of the forms.

The structure contains in all 6,500 cu. yds. of concrete and 500 tons of reinforcing steel. It will be entirely completed about the end of next month.

The contractors are Wells & Gray, Limited, Toronto. The reinforcing steel was supplied by the Burlington Steel Co., Limited; the cement, by the Canada Cement Co.,

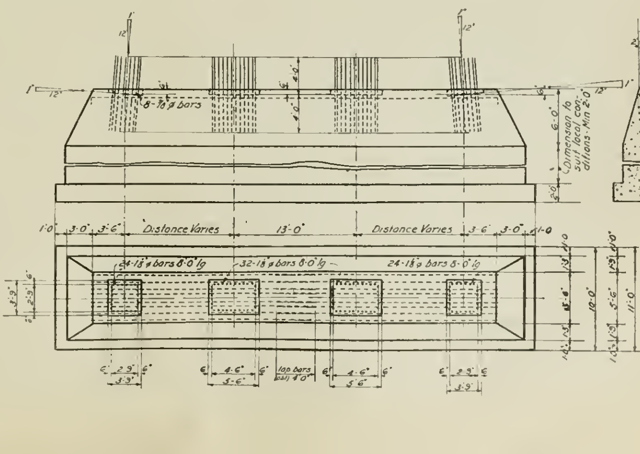


Fig. No. 4 Detail of Piers

Limited, and by Alfred Rogers, Limited; and the waterproofing, by the Carmichael Waterproofing Co., Limited.

The work was carried out under the supervision of J. H. Barber as resident engineer for the Canadian Pacific Railway Co.; Geo. Hoshal, resident engineer for the contractors; and Harry Rowe, superintendent for the contractors. The trestle was designed by the bridge engineering department of the Canadian Pacific Railway Co., at Montreal, under the direction of P. B. Motley.

Part of a Completed Bent

Reconstruction of Belgium

The magnificent courage and dauntless optimism of the Belgian people are reflected in a letter received this week by The Canadian Engineer from Alb. van Hecke, secretary to Hon. G. Helleputte, Minister of Agriculture and Public Works of Belgium, asking that the minister's name be placed at once upon the subscription list of the paper, which is "to be used immediately in the preparation of designs and specifications for the reconstruction of Belgium." The headquarters of the Belgian Government are temporarily at Ste. Adresse, Le Havre, France, but we hope that they will soon be firmly re-established at Brussels, Belgium.

CANADIAN GOOD ROADS CONGRESS

The Fifth Canadian Good Roads Congress will be held May 7th to 10th, 1918, in the ball-room at the Royal Connaught Hotel, Hamilton Ont. George A. McNamee, the secretary-treasurer of the association, says that an interesting and educational program of lectures has been arranged, and that current problems dealing with road construction and improvement will be discussed. A question box will be a feature of this year's meeting. Samples of road materials will be on exhibition, but practically no heavy machinery owing to transportation difficulties.

Delegates and visitors will register at the hotel headquarters before entering the meeting hall. They will be supplied with badges.

Among the topics, discussion of which has been arranged, are the following:—

The Road and the Farmer; Who Should Pay for the Road; The Efficiency of the Highway in the Present Transportation Difficulties; The Most Important Consideration Entering Into Road Construction,—Drainage; Modern Practice in Bituminous Pavements; English and American Practice in the Construction of Tar Roads; Concrete Roads; Abatement of the Dust Nuisance; Roads for the Common People,—Gravel and Macadem; The Labor Shortage Solved by Efficient Machinery.

W. H. Connell, of Philadelphia, will read a paper on "The Results of Tests With Various Types of Pavements," giving data on a test road fifteen miles long near Philadelphia on which twenty types of paving were tested.

Lieut.-Col. W. G. McKendrick, who has just returned from the Front, will contribute a paper on "How the Good Roads of France are Helping to Win the War."

Capt. J. A. Duchastel de Montrouge, city engineer of Outremont, P.Q., is president of the Association this year, having been re-elected for a second term. S. L. Squire, municipal adviser of the Ontario Government, is vice-president. The honorary presidents are U. H. Dandurand, of Montreal; W. A. McLean, Deputy Minister of Highways, Province of Ontario; B. Michaud, Deputy Minister of Roads, Province of Quebec; and Capt. O. Hezzlewood, Toronto.

The directors are the above-mentioned officers and Thomas Adams, town planning adviser, Commission of Conservation, Ottawa; A. L. Caron, president, Automobile Club of Canada, Montreal; Dr. E. M. Desaulniers, M.L.A., deputy speaker, Provincial Legislature, St. Lambert; R. S. Henderson, president, Manitoba Good Roads Association, Winnipeg; Geo. Hogarth, chief engineer, Highways Department, Province of Ontario, Toronto; J. W. Levesque, M.L.A., Montreal; A. F. Macallum, commissioner of works, Ottawa; P. E. Mercier, chief engineer, City of Montreal; J. A. Sanderson, Oxford Station, Ont.; C. R. Wheelock, president, Ontario Good Roads Association, Orangeville; W. G. Yorston, assistant road commissioner, Province of Nova Scotia, Halifax; and W. Findlay, business manager, The Journal-Press, Ottawa.

CAN. SOC. C.E., MONTREAL BRANCH

This evening Ulric Valiquet, M.Can.Soc.C.E., supervising engineer Department of Public Works, Ottawa, will read a paper on "Champlain Dry Dock for Quebec Harbor," before the Montreal Branch of the Canadian Society of Civil Engineers.

Lieut. Philip Bruneau, of the Canadian Machine Gun Corps, who is now on furlough, will describe machine gun work in Flanders.

MEMORIAL TO THE GOVERNMENT

A memorial has been forwarded to the Prime Minister, protesting against the employment of American architects, engineers and contractors on Federal Government work, and making the request that in the construction of Dominion public works, Canadian architects, engineers and contractors be given an assured preference. While the government has made no reply, it is unofficially understood that the majority of the members of the Cabinet, including the Premier, recognize as self-evident the soundness of the basic contentions outlined in the memorial, and that there will be more careful observance of national interests in the future by the various departments at Ottawa. It is pointed out that while some appointments of American individuals and firms on public work for the Dominion Government, have been well justified by special circumstances, other such contracts and appointments by the Federal Government have been not only unnecessary but also really against the national interest from many broad viewpoints. No mention of private contracts or municipal or provincial undertakings is made in the memorial, which is evidently aimed chiefly at the award of the Lindsay Arsenal contract to Westinghouse, Church, Kerr & Co. The full text of the memorial is as follows:—

"The undersigned, for themselves and the several interests represented by them, desire to lay before the government certain considerations arising upon the persistent and growing practice of employing alien architects, engineers and contractors on large public works in Canada.

"The matter has assumed such proportions as to render inevitable the humiliating suggestion that Canadian architects and engineers are considered incompetent to undertake work of the character in question. This suggestion itself, apart from any economic consequence, is of such serious import to Canadians and to educational institutions, in which their professional men have received their training, that it cannot be allowed to pass without earnest protest. That the Canadian Government should give ground is so unmistakable a fashion for the inference of Canadian inferiority is a matter of painful concern to every educationalist and technically trained man in Canada.

"The immediate occasion of this Memorial is the awarding of the contract for the new Government Arsenal at Lindsay, but the submissions to be made have reference to principles and economic effects which this contract serves to illustrate, and which has been otherwise exemplified. As regards the construction of the Government Arsenal, it is desired to submit that if any special devices, inventions or designs were required, the natural recourse would be to Great Britain.

"It should not be necessary to point to past achievements by Canadian architects, engineers and contractors in the construction of our public buildings, railways and other works. We submit what we hold the government should assume as axiomatic, that Canadian brains and skill are adequate to undertake any public works in Canada. If any special requirements were in view, it is submitted the proper course would be to follow the established usage in Great Britain, *viz.*, to send local architects and engineers to visit cities and countries where models are to be found, rather than to employ foreign architects and engineers.

"But there are other considerations of serious importance. Foreign architects and engineers naturally tend to employ materials with which they are familiar. Hence the practice of specifying materials, devices and designs of foreign manufacture to the serious prejudice of Canadian manufacturers and workmen.

"Similarly, in the matter of contracts and subcontracts, there is an inevitable discrimination against Canadian contractors.

"Apart from the fact that alien architects, engineers and contractors have no community interests in Canada, and escape its fiscal burdens, the employment of foreign firms has the inevitable effect of discouraging Canadians who have, and who might take up, architectural, engineering and other professions in this country, and of encouraging them to practise those professions in other countries instead, thus draining the country of service, skill and young manhood resources which should be preserved to Canada.

"Furthermore, the policy of which we complain is inconsistent with the efforts which are being made through our universities and other educational institutions to develop into a high state of efficiency the young men of the country. The conservation and development of the manhood resources of the country, no less but rather more than our material resources, are the concern not only of the interests represented by the undersigned, but of the whole country, and we submit they should receive the most careful consideration of the government.

"It is desired therefore:

"(*a*) To protest against the action of the War Purchasing Commission, acting for the Federal Government, in employing aliens for the construction of the Government Arsenal at Lindsay;

"(*b*) The protest against the increasing frequency with which foreign professional men are employed on important public undertakings in Canada;

"(*c*) To urge that the government should not create precedents which of necessity influence private owners of works against the employment of Canadian architects, engineers and contractors;

"(*d*) To urge that in construction of Canadian public works, Canadian architects, engineers and contractors should be given an assured preference."

The following signatures are attached to the memorial, per the authorized officials of the various organizations:—

Council of Royal Architectural Institute of Canada.
Royal Architectural Institute of Canada.
Ontario Association of Architects, Toronto, London, Ottawa and Hamilton Chapters.
Manitoba Association of Architects.
Alberta Association of Architects.
Saskatchewan Association of Architects.
Province of Quebec Architects.
Architectural Institute of British Columbia.
Association of Architects, Quebec.
Canadian Society of Civil Engineers.
Engineers' Club of Toronto.
American Institute of Electrical Engineers, Toronto Branch.
Engineering Alumni of Toronto University.
Engineering Society of Queen's University, Kingston.
Toronto Builders' Exchange, Master Masons' Section; Master Carpenters' Section; Master Plasterers' Section.
Builders' Exchange (Incorporated), Montreal.
Ottawa Builders' Exchange.
Owen Sound Architects, Engineers and Contractors.
Peterborough Builders' Exchange.
Essex Builders' and Architects' Association.
Stratford Builders' Exchange.
London Builders' Exchange.
Woodstock Builders and Supply Dealers.
St. Mary's Builders' Exchange.
Hamilton Builders' Exchange.
St. Catharines Builders' Exchange.
Galt, Preston and Hespeler Builders' Exchange.
Roofers and Sheet Metal Manufacturers' Association, Brick Manufacturers; Reinforced Concrete Section; Builders' Supply Section; Provincial Builders and Supply Section.

CORROSION OF SERVICE PIPES*

SOME trouble has been experienced with corrosion of service pipes, presumably due to the carbonic acid in the water, and a series of tests were made with the waters from the different purification plants. At Mt. Hope, 48 ft. of new ¾-inch galvanized wrought iron pipe was tapped into a 4-inch cast iron main running through the pipe gallery, which furnishes the supply of water for the ordinary daily use in the camp. An ordinary brass faucet was placed on the discharge end. Water was turned into this pipe on June 23rd and run through it continuously, with two exceptions, at the rate of about 1 gallon per minute from 8 a.m. to 5 p.m. each day. From 5 p.m. to 8 a.m. the water stood in the pipe, the faucet being closed. Each morning daily determinations of alkalinity, free carbonic acid, color and iron were made of samples of the first water drawn off in the morning, designated as "over-night" samples; also of running water collected about one hour later and designated as "running" samples. The pipe was under observation for 373 test days. Up to August the free carbonic acid in the "over-night" samples was much higher than in the "running" samples. The alkalinity was lower, and the color and iron were about equal. The free carbonic acid ordinarily ranged between 35 and 40 parts per million in the over-night samples and 3.5 to 5.0 in the running samples. After September 20th the free carbonic acid contained in the over-night samples was less than that in the running samples.

It was concluded from these tests that the effluent from this filter plant exerts only a slight corrosive action on pipe that has been properly galvanized, and will form only a thin coating on the interior. This conclusion has been corroborated by examination of the pipe used in this experiment and also of a service pipe from Cristobal.

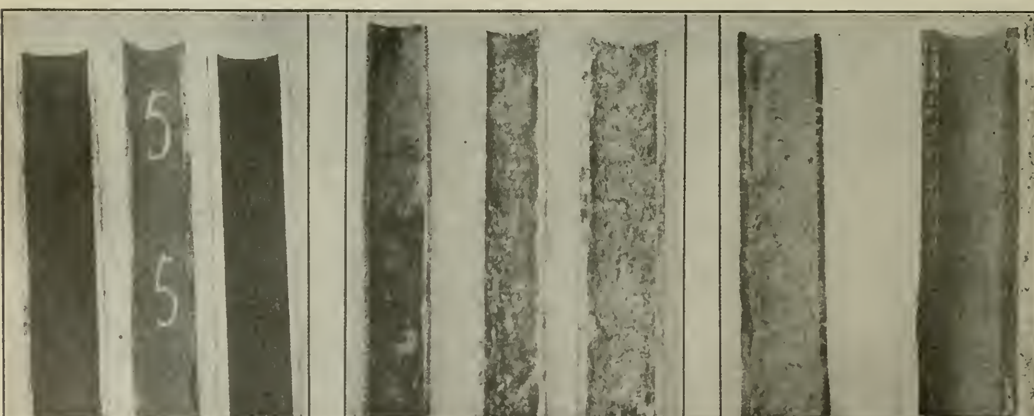
Similar experiments were made on lead pipe with effluent at the Agua Clara purification plant, 25 ft. of new 1-inch lead pipe being used. In the over-night samples the amount of lead increased to a minimum of 2.33 parts twenty-one days after the water was turned into the pipe, and from this time there was a decrease, and three months later the lead contained in 19 out of the 21 samples was 0.3 parts or less. As would be expected, the amounts of lead dissolved by the water standing over night diminished as the free carbonic acid was replaced with carbonate alkalinity. Of the running samples, only three contained as much as 0.1 part per million, and the majority less than 0.06 part. At the end of the test a section of the pipe was split, and the inside was found to be covered with a very thin coating of calcium carbonate. From these experiments the conclusion was drawn that the use of lead service pipes in the districts supplied by water from this plant is attended with no danger of lead poisoning so long as a carbonate alkalinity is maintained. It would be advisable, however, to allow the water which has been standing over night in a lead service pipe to run to waste during the first two months after its installation.

At this plant a test was made of the effect on galvanized iron pipe also. Throughout this experiment, lasting 380 test days, the alkalinities of the over-night samples were higher than those of the running samples, but the difference was always less than on the first two days, ranging from 1 to 11 parts. The colors of the over-night samples also were always higher than those of the running samples. They were also always higher in iron.

Gravimetric determinations of zinc were not made on the water from the galvanized iron pipe, but at the end of the run the residue from 100 c.c. of an over-night sample was tested micro-chemically and zinc crystals obtained; while a similar test of a sample of running water, collected on the same day, showed the absence of zinc. There was a cloudy appearance of the over-night samples that may be explained by the presence of iron and zinc in suspension.

While it was known that galvanized iron was not suitable for service pipes with a filtered water of low alka-

*Abstracted from 1917 report on Water Supply for Municipal Purposes in Panama Canal Zone.



Split Service Pipes, Showing Interior Conditions

No. 1.—Galvanized iron pipe removed after 5 years' service. Galvanizing removal and iron incrustation due to low residual alkalinity and free carbonic acid in filtered water.
No. 2.—Experimental galvanized iron pipe at Mt. Hope purification plant. In service one year.
No. 3.—Galvanized iron service pipe removed after 10 months' service, Ancon, C.Z. Water from Miraflores purification plant. Thin coating of iron oxide.
No. 4.—Experimental galvanized iron pipe at Agua Clara purification plant. In service one year.
No. 5.—Experimental galvanized iron pipe at Agua Clara purification plant. In service one year.
No. 6.—Galvanized iron pipe removed after 7 months' service from a house connection in Gatun, C.Z.
No. 7.—Service line to Incinerator, Gatun, C.Z. Flow through pipe about 3,000 gallons per month.
No. 8.—Experimental lead pipe at Agua Clara purification plant.

linity and a free carbonic acid content of 5 parts or more, on account of the removal of the zinc and corrosion of the iron, it was thought that if a normal carbonate alkalinity were maintained the corrosive action would be slight and the physical appearance of the water standing one night would not materially differ from that running a few minutes. It was observed, however, that while the overnight water was not colored yellow to the extent that it was prior to the removal of the free carbonic acid, yet it presented a slight milky appearance and was not as clear as water drawn off a few minutes later. At the end of the test this pipe was split open for examination, and at the end bearing the brass faucet there was a uniform soft deposit of a brownish color that shaded off to a cream color about one inch back. This was undoubtedly the result of galvanic action. It is reasonable to assume that particles of this soft deposit might have been loosened when the faucet was opened in the morning, thereby accounting for some of the higher iron contents. The zinc coating on the interior of the pipe was in good condition with the exception of a few small pin-head deposits. There was a very thin slate-colored coating over it. A section cut from about mid-length of this pipe did not contain any rust, but was spotted with cream-colored tubercles ranging in size from a pin-head to irregular deposits ⅜-inch long, ¼-inch wide and 1/16-inch thick. Near the cast iron main the thin coating over the zinc was colored brown in spots and cream-colored tubercles also were present. The interior surface of this piece was much rougher than that from the mid-length of the pipe, and it was evident that dross from the spelter bath had adhered to the surface.

Examination was made of a one-inch galvanized iron pipe that had served as a service to a cottage for about six months. About 12,000 gallons of water per month had passed through this pipe. A piece was also cut out of another service about 1,000 ft. long which had been in use about seven months. The condition of these two pipes was such that the continual use of galvanized iron pipe was considered inadvisable, not on account of the corrosion of the zinc coating, but because the soft deposit will reduce the capacity in a comparatively short period. The rate of accumulation of this deposit varies with the amount of water passing through the pipe, the smaller the flow and the greater the periods of time between discharges, the more quickly the incrustation forms.

It is evident that at the temperature of water prevailing in service pipes in the tropics (24 degrees to 30 degrees Centigrade), the normal carbonate alkalinity as $CaCO_3$ must not exceed 8 parts per million as a provisional standard, with the possibility that this limit may be too high; instead of the 13 parts given by Whipple as a maximum beyond which precipitation will occur.

A piece of one-inch galvanized iron pipe which had been in service for five years was found to be covered on the interior with a rust-colored deposit from 1/16 to 3/16 of an inch thick. All of the zinc coating had disappeared. This furnished an excellent illustration of the action of a soft water that had been treated with alum with the resultant residual alkalinities varying from 2 to 10 parts per million and containing an average of 6 parts per million of free carbonic acid.

Saskatchewan province has been divided into eight districts under the Highways Act, and superintendents have been appointed as follows:—Battleford, F. Kissack; Prince Albert, F. McDougall; Saskatoon, W. Grant; Yorkton, E. B. Webster; Regina, C. F. McLellan; Weyburn, J. T. Cameron; Moose Jaw, A. McCallum; Swift Current, J. R. Reid.

ESTIMATING SEWAGE FLOW FROM FLOOR AREA*

By Walter S. McGrane
Assistant Engineer of the Bureau of Sewers, Manhattan Borough.

THE usual method of estimating sewage flow on the basis of resident population is unreliable and misleading for a municipal district like that of lower Manhattan, with its tremendous daily influx of transients in the office buildings, hotels, department stores and manufacturing buildings. In certain wards the resident population is steadily decreasing, although the number of individuals in the ward during business hours probably is not. In fact, the areas where most losses in resident population occur, owing to business buildings replacing residences, are the areas in which the amount of transient population is the greatest. This transient population, especially that in hotels, contributes a material amount to the sewage of the district.

This population is dependent upon the area of floor surface occupied; that is, in the case of a building that extends full size to the roof, upon the ground space occupied by the building times the number of floors in the building. Some statistics taken by the Sewer Bureau in department stores and hotels show actual densities of daily working population in department stores varying from 865 to 2,670 per acre (including street surface), this varying with the season of the year; while in hotels the density varied from 770 to 2,630 per acre. These figures do not include the number of people shopping in department stores or those in the hotels who are not either guests or employees.

William W. Brush, in making estimates for the Catskill water supply, made an investigation from which he decided that "other things being equal, the amount of water used in any building would be dependent upon the ground area covered and the number of stories in height." He decided that the amount of water used in any building is proportional to the size and height of the same. The total floor area can readily be obtained from available atlases of the city. Meter readings of hotels and business buildings taken in 1916 show the average consumption of six of the best hotels to be 526 gallons per thousand square feet of floor area, varying from 368 to 694. Five tenement and apartment houses gave an average of 230 gallons per thousand square feet, varying from 138 to 295; and five office and manufacturing buildings gave an average of 250, varying from 194 to 271. Each class of buildings gave a peak load about 25 per cent. higher than the average.

In most cities, anything like accurate forecasting of consumption would be complicated by the difficulty of estimating the number of floors to which the buildings in the several districts would be carried; but New York now has zoning laws which limit the heights of buildings in the different zones, and it can be assumed as a maximum that all of the buildings in a zone will reach the maximum permissible height. In the calculation for Manhattan, the total area is reduced by 33 per cent. to allow for streets, and this net area is further reduced by 15 to 30 per cent. for court areas required by law. The building area thus obtained is then multiplied by the average number of floors, giving the total floor area; and this area, expressed in units of 1,000 sq. ft., is then multiplied by the constant gallons-per-day factor for the class of buildings which is

*Abstract of paper read before the Municipal Engineers of the City of New York.

expected to occupy the district in question. For convenience in sewer calculation, this is reduced to cubic feet per second per acre of total area.

Gaugings of sewage flow from typical areas were made from time to time in different parts of the city to assist in determining the factors to use in calculations of this kind. In making these sewer gaugings, various appliances were used, including floats, pitot tubes, current meter and one or two others. The writer, who had charge of the work, decided that the float method, properly checked by pitot readings, was probably the most practical for gauging sewage flow under conditions found in Manhattan Borough. Difficulty was experienced in carrying on the work because of the presence in some sewers of great quantities of gasoline vapors, illuminating gas and steam; also, occasionally, great depth of mud near the outlets, obstructions from pipes, back-water from tides, excessive velocities, poor light, and last but not least, the influence of large house connections.

Having decided upon the point for making a gauging, the sewer was cleaned for a distance 100 feet each way from the section by the cleaning gang of the department. The distance between the centres of two manholes was accurately measured, an extension-leg level and short rod were used for running a line of levels on the sewer invert with readings at 10-foot intervals, and the cross-section of the sewer at a point near each of the two manholes was measured. The party usually consisted of five men when engaged in putting floats through and six men when taking pitot readings. In the former case, one man remained on top at the up-stream manhole and two men at the bottom of this manhole, one to start the floats and the other to keep the time. At the down-stream manhole there was one man on top guarding the hole and one on the bottom to receive the floats and call out the time. While sending the floats through, the height of the sewage is taken at regular intervals, being measured down from a plank set horizontal and whose elevation is taken accurately. The surface floats used at first consisted of wooden strips 4 inches by 8 inches by ½ inch, but it was finally decided that better results were obtained by using a float to the bottom of which were nailed two tin vanes at right angles to each other and extending 3 or 4 inches at right angles to the board; the object of the vanes being to catch the maximum velocity, which was about one-fourth of the depth below the surface.

The mean velocity used in calculating volumes of flow was obtained by multiplying the float velocity by a coefficient varying from 0.75 to 0.80. To check the coefficient, a pitot tube was used, consisting of a glass tube two feet long and ½ inch in diameter, bent 45° at one end and tapered off as a cone which terminates in a small cylinder about 1/32 of an inch in diameter. The tube is set so that the lower end is horizontal and the main part of the tube makes an angle of 45° with the vertical. This position serves the purpose of exaggerating the velocity head to facilitate the accurate measurement. The combined virtues of the nozzle and standard short tube are found in the shape of the cone and tip, giving a very high coefficient of 0.98. In spite of the fact that the tip was continually clogging when immersed in the flow, this appliance gave very good results. In using the pitot tube, a frame was employed to which the tube was fastened, this frame being so constructed that it could be slid along a horizontal board set in the sewer, and the tube slid up or down along the 45° bed of the frame so that the pitot end could be brought to any part of the cross-section. The cross-section was then divided into a number of small imaginary sections of equal area and a reading taken at the centre of each section. The difference between the static elevation and velocity head was measured directly from the tube.

In rating the floats, these were put through the sewer at the same time the pitot readings were being taken and for as short a distance above and below the pitot station as it was practicable to use and obtained precise velocity readings.

One of the greatest sources of error encountered in measuring sewage flow arose from the influence of house connections, especially the larger sizes. If the house connection entered above the surface of the sewage, or if the sewer section was narrow or the velocity flow more than 3 feet per second, the effect was not so marked. But when the house connections were near the flow line, the sewer section wide, and the velocity below 3 feet per second, the effect on float velocities might be considerable. In making a velocity determination, five floats were put through, one after the other. From a considerable number of observations it was decided that if the five floats did not vary more than 2 per cent. or 3 per cent., probably no house connections were operating and the arithmetical mean was used. If one float varied 3 per cent. to 6 per cent. from the mean of the other four, the length of route covered by the float was assumed to be greater than the straight length of sewer by eight-thirds of the extreme variation caused by the float swinging first as far as possible to one side and then the same distance to the other side of the centre line of the sewer. If the tardy float was 6 per cent. to 10 per cent. behind the others, sixteen-thirds of the extreme variation was added. If the tardy float was more than 10 per cent. behind the others, it was discarded as an observation.

In one case a standard sharp-edge weir with a stilling-box arrangement was used and gave very accurate results; but it was concluded that placing weirs in sewers is seldom practicable, since the weir must be made water-tight and yet so constructed that it can be removed readily in case of storms in order to prevent the flooding of cellars; and it was found almost impossible to satisfy both conditions. In addition to this, the presence of the weir causes the precipitation of great quantities of solid matter behind it which tends to back up the sewage into the house connections. Attempts made to measure the sewage flow by means of a current meter were unsatisfactory, owing to the fact that suspended matter clogged the mechanism.

At the time of writing this paper, a few weeks ago, the writer was experimenting with what is known as the Sanborn automatic gauge, utilizing pneumatic pressure, which had up to that time given better results than others which had been tested, although it required more or less constant attention.

The Vancouver Gas Co., Ltd., have installed new gas retorts which considerably enlarge their output of coal gas. Ammonia liquor—formerly wasted—is now being made in the new plant, and is used by the Victoria Chemical Co., Ltd., Victoria, in the manufacture of their product.

A plant for the construction of concrete ships is to be erected at Cleveland, Ohio, by the Cleveland Builders' Supply Company. Construction will be limited exclusively to concrete ships and barges. The plant will be the first of its kind on the lakes. The size of the vessels will permit their passage through the Welland Canal. Ships of 2,000 tons capacity and barges of 1,200 tons capacity will be built. They will be more than 200 feet long and 38 feet wide. The plant's output is expected to be about four ships per month.

Letters to the Editor

FEDERAL ENGINEERING SERVICE

By C. E. W. Dodwell

Sir,—I cannot doubt that your valuable journal is open at all times to the advocacy of a good cause, especially when that cause is identified with the welfare and advancement of the engineer and the elevation of the profession of engineering, therefore I have confidence that you will find room in your columns for a brief history of the cause to which I refer, and a presentation of its grounds and objects.

Before proceeding, let me say here that this cause is the establishment of a proper and thoroughly organized engineering service for the Federal Government

Seventeen Years of Effort

For seventeen years the engineers in the employ of the Federal Government have been striving to ameliorate, or work a reformation of, the disabilities and anomalous position under which we have always labored. Up to the present time our efforts have not been rewarded gy any appreciable measure of success, and were it not for the fact that the overcoming of difficulties is the pride and the distinguishing feature of our profession, we should ere this have succumbed to discouragement, ceased our endeavors and accepted the apparently inevitable.

Last February, the result of a general election was that for the first time in the half-century of the history of Canada, a Union or Coalition Government was established, and the old party lines were, temporarily at least, obliterated.

The avowed policy of the new government is "civil service reform with a view to extending the principle of the Civil Service Act to the outside service and thus abolish patronage, and to make appointments to the public service upon the scale standard of merit." Therefore, in spite of the intensity and the absorbing character of the government's war efforts, we believe that the present juncture offers a favorable occasion in which to urge the reasonableness and justice of our cause.

As briefly and concisely as possible, let me set forth the history of our movement.

History of the Movement

In March, 1901, the engineers of the Public Works Department from the Atlantic to the Pacific, forwarded to the minister, through the chief engineer, a petition praying that the engineers of the Public Works Department might be included in the civil service and given an improved official status. We have heard nothing of it since, nor even had an acknowledgment of its receipt.

In February, 1906, Mr. Hyman, then Minister of Public Works, who seemed to take more interest in the engineering service of his department than any former minister, summoned all the resident engineers, from the Atlantic to the Pacific, to meet him in Ottawa. We assembled to the number of about thirty-five and had four days at the capital at public expense. The minister gave us a good dinner at the Russell House, at which in a very nice speech he told us that we were the very finest body of men and engineers that ever were; that he had in preparation a comprehensive scheme of reorganization of the whole service, including substantial increases in salaries, and that he hoped in a very short time to be able to make known to us the details of this long-hoped-for reformation. The minister's promise as to salaries was made good to the extent of two subsequent increases, and for that we were not without at least that gratitude which has been described as "a lively sense of favors to come." At this meeting, which seemed a very and peculiarly fitting occasion for presenting in person before the minister our views and wishes in regard to improved official status, we were not afforded any opportunity of so doing, and there was not a man among us with sufficient courage to take the bull by either the horns or the tail.

Other Engineers Included

For five years nothing was done. In the interim, however, our ideas very properly expanded, and our efforts were directed to the inclusion not only of the engineers of the Public Works Department, but of all engineers in the permanent employ of every department of the federal government, in one comprehensive, regularly constituted and organized service.

On the 17th of January, 1910, the Hon. A. B. Warburton, M.P. (Queens, P.E.I.), in an able speech in the House of Commons, championed our cause and advocated the establishment of an engineering service in Canada similar to the corresponding services in India and Australia. To this speech the Hon. W. Pugsley, Minister of Public Works, replied in favorable and encouraging terms.

On the 25th of January, 1910, at the annual meeting of the Canadian Society of Civil Engineers, the subject of "an improved and regularly organized engineering service for the federal government" was discussed at length. The sympathy and support of the society as a body was pledged to the movement, and a committee was appointed to take up the matter, draft a memorial to the premier and take such other steps as might appear wise and efficacious. So far as I am aware, the society did nothing further in the matter.

In 1910 the engineers in federal employ, with excellent parliamentary and legal advice, prepared a "bill to organize and establish the engineering service of the government of Canada"; of which more anon.

On the 14th of November, 1910, a meeting of prominent government engineers, representing all departments, was held in Ottawa, at which it was resolved to carry on a vigorous campaign, and a committee was appointed.

Prime Minister Meets Delegation

On the 20th of January, 1911, the premier, Sir Wilfrid Laurier, received a delegation of about thirty engineers, most of them in government employ, but including the president and secretary of the Canadian Society of Civil Engineers and several other eminent engineers not in government employ. At this meeting a carefully prepared petition or memorial, signed by all engineers in federal employ, was presented to the premier.

Our cause was admirably presented in eloquent and forceful speeches by Col. W. P. Anderson, chief engineer of the Department of Marine and Fisheries; Mr. Marceau, past president, Canadian Society of Civil Engineers, representing the Department of Railways and Canals, in charge of canals in the province of Quebec; and W. F. Tye, president Canadian Society of Civil Engineers, chief engineer of the C.P.R'y. To these speeches the premier and the Hon. William Pugsley, Minister of Public Works, replied in favorable terms, the former requesting the latter, as having more engineers in his department than there were in others, to take up the matter. Dr. Pugsley suggested the formation of a small and active committee, with which he could deal directly and conveniently, and

for this purpose he named the chief engineers respectively of the departments of Public Works, Marine and Fisheries, and Railways and Canals, and of the Railway Commission.

On the 30th of January, 1911, Dr. Pugsley received this committee and requested it to prepare a bill for presentation to council on the 3rd of February, 1911.

Several times since the last mentioned date our bill has been *very nearly* presented to Council, but, owing to one reason or another—the urgency of other measures, etc.—it has not yet been taken up by the government, and we still live in hope.

In regard to the bill itself. Its objects in the order of (my conception of) their importance and desirability are:—

First, a higher professional standard.

Second, a recognized official status by enrolment in the civil service.

Third, a system of pensions and superannuations.

Higher Professional Standard Wanted

With reference to the first object: The engineering services of the several departments of the federal government have, at present, no recognized professional standard whatever, and the individual engineers in government service are certainly not, as they ought to be, conspicuous by their professional superiority over engineers who are not in government employ; indeed, a larger measure of truth would attach to the converse proposition. When an engineer is appointed to a government post, he is not required to pass an examination; he is not asked to produce testimonials, diplomas or credentials; he is not questioned as to where or how he acquired his professional knowledge and training, or whether he has ever had any education whatever,—scientific, technical or general. He is, or may be, at once put into a position of responsibility in which the judicious expenditure, or waste, of public money depends upon his knowledge and experience as an engineer, and upon his judgment, integrity and commonsense as a man.

If the engineering service of the government were properly constituted and organized, and a high standard of knowledge and experience made essential, it would be one of the most useful and profitable institutions of the country, and millions of public money would be saved. In a young country like Canada, with an area equal to that of the United States but with a population less than that of the city of London, with all the industrial capabilities and natural resources that go to make a country great, it is hard to over-estimate the importance of the civil engineer in the national development.

A distinguished English engineer, James Charles Inglis, president in 1909 of the Institution of Civil Engineers, in his inaugural address, said:—

Qualified Engineers Should Be in Control

"It ought to be laid down as a principle, that all public money derived from rates and taxes, should, so far as it is applied in engineering construction, be expended under the direction or control of definitely qualified engineers, as is already the case in many countries."

If this is true of a country like England, which has, in a sense, reached its maturity, it is infinitely truer of a country in a vigorous infancy, like Canada.

It appears to me that as a first step towards a higher professional standard for government engineers, one of two requirements should be an indispensable qualification for appointment:—

(*a*) The passing of a proper examination; or,

(*b*) Membership in some recognized engineering society.

In another part of his address, Mr. Inglis said:—

"Several important departments of state rely to a considerable extent upon the work of the council and, in some cases, upon advice given by it with respect to questions of the qualifications of engineers and of their selection for public services. The result of all this strengthening of the efficiency of the Institution is that a higher average technical proficiency is undoubtedly attained by the young engineers attached to it than was formerly the case, and this state of affairs has been notably marked by the action of the India Office with respect to engineering appointments in the Public Works Department; and very recently, by the War Office, which has entrusted to the council of the Institution the important function of selecting and recommending young engineers for nomination to the newly organized reserve of officers for the Royal Engineers. . . . The War Office has assigned to the president of the Institution the duty of selecting men for nomination to this reserve, as may be required from time to time."

British Institution is Consulted

If the Imperial Government can thus find it profitable and expedient to consult the Institution of Civil Engineers (the leading society of its kind in the world, with a membership, in all classes, of nearly nine thousand, scattered all over the globe) it will surely be worth while, and in the public interest, for the Canadian Government to consult the Canadian Society of Civil Engineers in regard to appointments and corresponding subjects.

It is proper that membership in some one of the several classes in the Canadian Society of Civil Engineers should be required as a just and proper indispensable condition precedent to appointment in our service. Unlike other professions,—law, medicine or even plumbing,—engineering, except in the provinces of Quebec and Manitoba, has no legal status, recognition or standardization by legislative enactment or statute, and any man, however uneducated, ignorant or incapable, has the right to style himself an engineer, and to solicit practice, and to undertake the design and execution of engineering works. Membership in the Canadian Society of Civil Engineers is the only guarantee, test, diploma or certificate that a man is a qualified engineer. The society was established in 1887 by Federal Charter, and under rules, regulations and by-laws prepared with extreme care and mature judgment, and with the sanction and approval of the government. The second clause of the charter clothes the society with "power to make and pass regulations and by-laws for the direction and management of the said society, including all rules that may be necessary for the maintenance of the honor and dignity of the profession." The government, therefore, has the right to expect, and may reasonably and confidently expect and demand, that the society will jealously guard admission to its ranks, and insist upon proper and adequate education, with scientific and technical training, as indispensable conditions precedent to membership therein.

Society Exercising More Discrimination

It is to be admitted that the society's list bears the names of a few men who should not be in it, but this is true of every similar society in the world. At this date the society, with a steadily growing membership of over 3,000, with encouraging development of influence, and, we hope, of usefulness, is capable of exercising, and does exercise, a greater discrimination in admission to its rank than was practicable in its early days.

In view, therefore, of the above considerations, I contend, and I think I speak for the society, when I say that

it would be in the public interest that no engineer should be appointed to the government service unless he is a member, in good standing, of one or other of the several classes of the society.

Regarding a recognized official status by enrolment in the civil service: When the Civil Service Act was passed in 1876, there were comparatively few engineers in any department of the Federal Government, and they would appear, at that time, to have been regarded as fifth wheels to the coach, as more or less necessary evils, temporarily employed to carry out specific works, and to be discarded at the earliest possible moment.

The Civil Service

Either by design, or through a remarkable lack of foresight on the part of the originators of the act, no provision whatever was made in it for the incorporation in the public service of a corps of engineers in any department of the government, and the fact that at no time during the thirty-two years which have elapsed since the passage of the act in question has there been, so far as I am aware, any attempt to so amend it as to make it include civil engineers, would seem to indicate that their exclusion from its provisions was by design and intent. Be this as it may, it is surely nothing more than commonsense, justice, and in the public interest, that civil engineers in the regular employ of the government, and in receipt of yearly salaries, should have and enjoy all the rights, privileges and responsibilities, official status and security of tenure, possessed by the various clerks and other officers, for whose ordering and behoof the Civil Service Act was passed.

By this act the service is divided into two classes:—

(1) Schedule A, Inside Service, *i.e.*, officers employed in Ottawa,—

(*a*) Deputy heads of departments.

(*b*) Officers who have special professional or technical qualifications.

(*c*) Chief clerks.

(*d*) First class clerks.

(*e*) Second class clerks.

(*f*) Junior second class clerks.

(2) Schedule B, Outside Service, *i.e.*, subordinate officers in departments of Customs, Inland Revenue and Post Office, employed outside Ottawa.

Under class *b*, schedule A, it would appear that engineers attached to and employed in the departmental offices and staff at Ottawa, might, and should be, in the civil service, but as a matter of fact, out of the dozen or more engineers in the Public Works Department, resident in Ottawa, only two are in the civil service.

Engineers Not Mentioned

Schedule B makes no provision for, or mention of, engineers, and therefore no engineers outside Ottawa, in whatever department or of whatever rank, can be put on the civil service list. The act provides minutely and exhaustively for the examination, appointment, promotion, salaries and retiring allowances of clerks and officers of all kinds and grades,—except engineers.

To determine, however, where a civil servant stands in regard to salary, increase of salary or superannuation, an exhaustive study must be made of the following Acts:—

Chapter 7, R.S.C.—An act respecting the civil service of Canada, 1876.

46 Vic. Ch. 18, R.S.C.—An act relating to the superannuation of persons employed in the civil service of Canada, 1886.

56 Vic. Ch. 13, R.S.C.—An act respecting government civil servants' insurance, 1893.

60-61 Vic. Ch. 15, R.S.C.—An act further to amend the Civil Servants' Superannuation Act, 1897.

61 Vic. Ch. 17, R.S.C.—An act to provide for the abolition of the Civil Servants' Superannuation Act and for the retirement of members of the civil service, 1898.

3 Ed. VII. Ch. 9, R.S.C.—An act to amend the Civil Service Act, 1903.

3 Ed. VII. Ch. 10, R.S.C.—An act to amend the Civil Service Superannuation Act, 1903.

7-8 Ed. VII. Ch.—An act to amend the Civil Service Act, 1908.

Inside Service and Outside

For my part, I could never see the object of the discrimination made by the Civil Service Act of 1876, and perpetuated in every subsequent amendment, between the inside service and the outside service. Such division has always appeared to be anomalous and uncalled for, creating unnecessary complications in the administration of the government service, and doing an injustice to the majority of the employees of the government throughout the Dominion. Surely a man is equally a servant of the government whether he performs his duties in Cape Breton, Ottawa or Vancouver Island, and it cannot surely be fair and reasonable, or in accordance with the most rudimentary principles of justice or the eternal fitness of things, that a responsible officer of the government in Halifax or Vancouver, with a salary of $2,000 or $3,000 a year, should be in a different and inferior position as regards status and tenure of office, to a junior third class clerk in Ottawa with a salary of $200 or $300.

It is my opinion, shared, I may say, by abler and more prominent men than I, with whom I have discussed the subject, that the whole of the acts cited above should be swept from the statute books and replaced by one comprehensive act dealing exhaustively with every department, abolishing the anomalous distinction between outside service and inside service, and bringing every permanent servant of the government into one fold, one category and one national and harmonious system.

Engineers Listed as Clerks

In the Public Works Department there are now over one hundred engineers, of which only three are on the civil list, and in it they appear not as engineers but as clerks; one as chief clerk, Engineers' Branch, Public Works Department, and another as a first class clerk. I cannot say why these three engineers are on the civil list, or why the other engineers at headquarters at Ottawa are not.

Early in 1908, when a commission was appointed by the government to make a thorough investigation into and report upon, the civil service, it was hoped by many interested persons, among them the engineers of the government, that the fruit of the commission's labors would be some such reformatory legislation as I have indicated. When, a little later, it became known that an amendment to the Civil Service Act was to be introduced before parliament at its last session, we thought that the fruit was already on the bough, and that the millennium was at hand. The amendment, which was introduced and in due time became law, makes no mention whatever of engineers, continues the thirty-two-year-old anomaly of sheep and goats, of an inside and outside service, and the latter is relegated to even greater obscurity than before. It is, indeed, mentioned only twice in the whole act; *viz.*, in section 3, where it is described as "the rest of the civil service," and in clause 3 of section 4, where it is provided that "the Governor-in-Council may bring the outside service within its operation."

Engineers in the government service, not being included even in the outside service, the act would require radical amendment and extension before they would be beneficially affected.

Pensions and Superannuations

While a system of pensions and superannuations has not the first place in the desiderata of the engineers of the government, it is a matter of great importance and one that might well engage the serious attention of the government.

I discuss "pension" as meaning money periodically paid to the widow or family of a deceased engineer, and "superannuation" as money periodically paid to an engineer honorably retired from active service.

Under existing conditions there is no pension whatever for the widow or family of an engineer dying in government service, even though he may have been in it for the best part of his life.

Section 43 of the new act provided that "if a person dies while in the public service after having been at least two years therein, an amount equal to two months of his salary shall be paid to his widow, or to such person as the Treasury Board determines." But it is not quite clear from the context, whether the words "in the public service" include persons not in the civil service; and to make the meaning quite clear, one way or the other, the words "public service" should be changed to "civil service," or after them should be inserted the words, "whether in the civil service or not."

In Sections 24 and 25 of the new act, where the words "in the public service" also occur, it is obvious from the context that they include persons not in the civil service, and therefore, in Section 43 the benefit of the doubt or ambiguity would no doubt be given in favor of an engineer dying in government employ, and his widow would be able at least to give him decent burial.

Hard to Save on P.W.D. Salaries

There are many engineers in the Department of Public Works and Railways and Canals, that have been in the respective services for periods ranging from twenty to forty years, men long past the prime of life, who have not been able either to save or invest enough out of their salaries, or to pay premiums on sufficiently large policies of life insurance, to enable their widows to pass their declining years in decency or comfort. To the question, "Should not these widows have pensions?" there is, of course, an answer, and so far as it goes, it is a pretty good answer. An engineer enters the government service presumably with his eyes open, and knowing well that if he dies in the service his widow will get no compensation. Therefore, he must be thrifty and himself provide a pension for his widow and family by devoting a substantial part of his not-too-large salary to the payment of premiums on a good, round life policy, or by putting aside what he can spare, or a little more than he can spare, in safe and profitable investments. But this presupposes a greater measure of thrift and prudence in the engineer than in other men, and it leaves out of account the fact that the widows of certain other employees of the government would and do enjoy pensions after their breadwinners have been taken from them. In no phase of the whole question is there a better illustration of the anomaly and injustice of the exclusion of government engineers from the civil service.

In the matter of superannuation, the government engineers are in precisely the same position as they are in regard to pensions. Even though they may have given their country faithful and efficient service for half their lives, they cannot look forward to any superannuation or retiring allowance, and their only resource is to die in harness before they are struck from the pay-list from incapacity due to age or infirmity, so as to secure for their widows and families the meagre allowance of two months' pay.

Value of Services

In striking contrast to this treatment is that accorded to servants of commercial and financial corporations. A well-known banking man, some few years deceased, on his retirement from the managership of one of the leading banks of the country, received his full salary, $20,000 a year, for two or three years after his retirement, a cash bonus of $50,000 and a retiring allowance of $6,000 per annum for life. Is there such a vast disparity between the value of service and responsibility of duties of a bank manager and those of the civil engineer in government employ as might be inferred from this difference in their treatment at the close of their useful careers? Surely not.

I have said before that there are a number of engineers who have been in the government service for twenty to forty years, and the question is, what is to become of them? Those of longest service and most advanced years ought, of course, to be retired on not less than two-thirds their salaries, and younger and more energetic men put in their places, but for this there is no provision whatever and they will drag along on the pay-sheet, the more onerous of their duties being performed by assistants, until some stony hearted new broom in the portfolio of public works—to use a somewhat mixed metaphor—throws them out on the scrap-heap.

But worse cases than these should be considered. Suppose a man in vigorous middle age meets with an accident, either in discharge of his duties or not, or is seized with blindness, paralysis, locomotor ataxia or some other dire ailment which, without killing him outright, absolutely incapacitates him from all further work. What is to become of him? He cannot continue to draw his salary because his place must be filled and his duties performed by another, and it is an axiom of government service that two salaries cannot be paid for one duty. He cannot be superannuated, because there is no provision for it. If he had the good luck to be killed outright, his family might have drawn two months' pay and given him a respectable funeral, but he continues to live, and, what is worse, to be a burden of trouble and expense to his family in doctors', nurses' and hospital bills, and the softest-hearted law on the Statute Book is powerless to help him.

Discrimination That Ruffles

In this case, as in that of the absence of pension for his widow, the engineer would have less ground, or even no ground, for complaint, if other employees of the government, certainly not more useful or of greater value to the public service, were not provided with superannuation at the close of their active careers. And it is not that the engineer begrudges the civil servant his pension, or would deprive him of it for the sake of establishing a uniformly ungenerous treatment throughout the public service, but it is the unjust, ungenerous and, as it appears to him, remedial adverse discrimination that ruffles and disturbs his ideas of the eternal fitness of things.

With the details of either a pension or a superannuation system, I need not here attempt to deal, further than to say that they present little difficulty. An accumulating annual deduction from an engineer's salary could be applied on ordinary actuarial principles to the purchase of an annuity for the engineer himself on his retirement, or for his widow on his death. Such a system, if properly estab-

lished and managed, would be automatic and self-supporting.

Having now dealt separately with each of the three aspirations of the engineering service of the government, let me, in conclusion, say a few words in regard to them collectively, because they are not distinct, separable or independent.

Doubtful Economy

I have tried to show that it would be in the public interest if the standard of qualification for government engineers were raised; that an engineering service of highest professional excellency is a matter of very great importance and would prove of vast practical value to the country. This may be illustrated in a crude and homely manner by supposing a great national work to be undertaken, as a means for the development of the country, such as a railway, canal, bridge or harbor. The work, under thoroughly competent engineering design and supervision, ought to be well done for a million dollars. It is designed and superintended by the best that government service can produce, an engineer enjoying a salary of $3,000 or $4,000 a year. It takes four years to complete and is so badly designed and built, that a second million has to be expended upon it before it can fulfil the object of its construction. If this hypothetical work had been designed and superintended by an engineer worth, and enjoying, a salary of, say, $10,000 a year, it would have been a success at the cost of the original million. The country has saved the difference between the $10,000 and the $4,000 engineer for four years, or $24,000, but to effect this saving has cost a million!

This is, perhaps, a rough and homely illustration, but, I submit, a fair one, and many a parallel could be found in the engineering history of the country in the past twenty years.

As an argument against a general increase of salary for government engineers, I have heard the fallacy advanced that the whole question is covered by the eternal laws of supply and demand, that the government would not be justified in paying higher salaries when as many engineers as are required can be employed at present rates of pay. To show the weakness of this line of reasoning, I have only to say that the government could to-morrow replace every engineer in its service by a new set of men at half the salaries now paid. But what sort of men would they be, and what sort of public works would they turn out?

Bigger Salaries, Smaller Costs

It is not a very far-fetched figure of speech to say mathematically that the cost of engineering works is inversely and their value directly in proportion to the salaries or rewards paid to their designers.

An an object lesson in the value of an efficient engineering service to the development of a country, look at that of the Public Works Department of India, of which the achievements in the construction of roads, bridges, railways and irrigation works are not only the admiration of the world, but have been of incalculable value to the country and to the Empire. As a service, it is unquestionably the best in the world. The competition for entry, the standards of qualifications, the educational training and the salaries, pensions and superannuations, etc., being all on a commensurate and magnificent scale. So far from there being any reasons why Canada should not have an equally good engineering service, the fact of ours being a larger and better country offers many cogent and obvious reasons why we should have, and some day will have, an even better.

If every engineer in the employ of the Federal Government would sink differences of opinion, petty objections and adverse and captious criticism on points of detail and minor importance, and direct their energies with unanimity and vigor to the furtherance of the cause that we have so much at heart, we may have confidence of a finally successful issue, but not otherwise; and this, through the columns of *The Canadian Engineer*, I urge them to do.

C. E. W. DODWELL,
M.Inst.C.E., M.Can.Soc.C.E.
District Engineer, P. W. Dept.
Halifax, N.S., April 11th, 1918.

WESTERN FUEL SITUATION

By John O. Newton

Sir,—It is only within the last few days that I have had the opportunity of reading the report appearing in your issue of January 31st last of the very able address delivered by B. F. Haanel, B.Sc., at the annual meeting of the Canadian Society of Civil Engineers, on the subject of the fuels of Canada.

It is only regarding the portion of his address that deals with the coal situation in Manitoba and the greater part of Saskatchewan, that I wish to trouble you. This stretch of country contains a population of about 360,000, reckoning only cities and those towns of over 1,000 inhabitants. The total population is probably nearer half a million, of which, roughly, half live in Winnipeg and its vicinity; consequently I think I may be pardoned if I confine my remarks on the coal situation in this area chiefly to Winnipeg, and to its ultimate dependency to a very large extent on the Souris Valley lignite fields, which are less than 300 miles distant, the nearest coal fields in Alberta being about 760 miles by rail, while Fort William is roughly 450 miles away.

May Influence the Government

The copy of your issue referred to was sent to me by a friend from Ottawa and was accompanied by a report on the economic possibilities of the carbonizing and briquetting of lignites by W. J. Dick, M.Sc., mining engineer of the Commission of Conservation. I understand that both were obtained from Mr. Haanel, and I therefore presume that Mr. Dick's report will have a very considerable bearing on whatever action is taken by the government with regard to the development of these very important lignite deposits.

It is reasonable to suppose that the importation of American anthracite and bituminous coal to Canada will be greatly curtailed in the near future, if not entirely eliminated. These coals are handled three times en route; firstly, at the American lake port; secondly, from the ship into storage at Fort William; and thirdly, from storage at Fort William to the train for final destination; the distance covered from the mine to Winnipeg being roughly 1,500 miles: a needless waste of rolling stock, tonnage and man power at any time, but more particularly during war. If we were left to the tender mercies of the Germans, this practice would soon be discontinued, and even with our slack methods of procedure, the chances are that it will in the very near future.

No Storage Facilities

If importation were prohibited, Winnipeg would be almost entirely dependent on the Alberta coal fields, from 760 to 860 miles away by rail. No facilities exist at any point in the West, excepting at Fort William, for storing coal in very large quantities, consequently coal for supply-

ing Winnipeg would have to be carried an average distance of 800 miles by rail almost direct from the mine to the consumer, and by trains moving in the same direction as grain is being moved. How can the railways handle such a situation? It looks to me so serious that public interest should be aroused and that immediately, and that some drastic remedy is required at once.

Possibilities of Raw Lignite

I take it from both Mr. Haanel's and Mr. Dick's statements that they lay too little stress on the possibilities of lignite in its raw state, and too much on the recovery of by-products. A good grade of the Souris Valley lignite can be used most successfully during the winter months in its raw state as substitute for other coal, provided it is burned in a furnace having a large combustion chamber and a good draught, and provided the public is instructed in its use. The latter is very important, for, if this lignite be treated like hard coal, satisfaction cannot be obtained.

I am not a coal chemist, neither am I a mining engineer. I am merely an average member of the public, who has looked a good deal into the fuel situation for the last few months from a commonsense point of view, and used no fuel but lignite all through the winter. I hesitated, and would continue to hesitate, about making any remarks on this subject at all, as I feel there are many others much more competent to do so than I, but when I see the possibilities of a report such as Mr. Dick's being taken into serious consideration, I cannot refrain from burdening you with these remarks, as I consider the situation so very serious that microscopic examination from all angles is required. In my humble opinion, an increase in the output of Souris Valley lignite by at least 1,000% is infinitely more important at the present time than the production of by-products that would to a large extent be wasted.

To obtain this output, seams of lignite should be mined close to a railway, at least 6 ft. 6 ins. thick and preferably a foot or two thicker, with ash content as small as possible, with water content as low as possible, the seams to have a hard roof that will stand the vibrations of coal-cutting machines, the seams to be free from clay or black-jack, and the calorific value of commercial samples to be as high as possible. I may state, however, that all such conditions cannot be obtained at Estevan, nor yet at Bienfait.

More Harm Than Good?

Upon close examination, I cannot but conclude that Mr. Dick's report is both inconsistent, inaccurate, too vague to be of any service, and misleading, and as such likely to do incalculable harm to instead of assisting those interested in developing this coal field. I presume you have already received a copy, so take the liberty of going somewhat fully into details:—

On page 13 of his report, the cost of U.S. anthracite in Winnipeg is stated to be $9.50 to $10 per ton; on page 17, it is shown as $11.25. No dates are given, but the actual winter 1917-18 price is $12.50 per ton delivered.

On page 12 it is stated that the freight charges on bringing coal from Shand to Estevan amounts to 40c. per ton (1917 rates); and from Bienfait to Estevan, 60c. per ton (1917 rates). Fifteen cents per ton must now be added.

On page 20 the B.t.u. of three samples of lignite on the dry basis are shown at 7,605, 8,073 and 6,388 respectively. If this is correct, we had better try elsewhere.

On the same page, the ash content of Taylorton coal is given on the dry basis as 8.1% and Bienfait mine, 5.90%. I am quite satisfied that if you take forty or fifty samples of coal from different parts of this area, analyze them as they come out of the mine and average the results, you will find the ash content between ten and eleven per cent. on the commercial sample, the content on the dry basis being roughly 25% higher. It is obviously unfair in any case to take three or four isolated samples, give no account of how they were obtained, and expect to procure reliable data therefrom.

Next, as to carbonized residue and gas. On page 9 it is stated that two tons of raw lignite will produce one ton of briquettes; and on page 11, that there will be a surplus of 4,000 cu. ft. of gas after firing retorts and by-product equipment, the calorific value of the gas being from 400 to 450 B.t.u. If this is correct, it is something entirely new to me, my limited knowledge showing a surplus of about 2,500 cu. ft. of gas per ton of a calorific value of from 390 to 400 B.t.u., when less than the above amount of residue is obtained. I must confess I should like satisfactory confirmation of Mr. Dick's figures on this point.

"Most Extraordinary Proposition"

On pages 10 to 13 are given particulars of the most extraordinary proposition I ever came across. We are shown an estimate of the cost of the raw material based on figures that are, to say the least, peculiar. No account is taken of the fact that there are bands of clay and in one case of black-jack in several of the seams of coal mentioned, that would have a very serious effect in raising the ash content of the slack. The fact is entirely ignored that raw lignite as mined is much to be preferred for carbonizing purposes to air-slacked lignite, and that the capacity, size, construction and design of the retorts will be dependent on the moisture content of the lignite concerned and its ultimate analysis.

We are told that a large part of the gas is to be used for brick burning, but we are not told that under present conditions only a very limited quantity of bricks is being burned.

Estevan is advised to buy 84 million cubic feet of gas per year, but we are not told what Estevan has to say about the matter.

It is admitted that even when all these things have been accomplished, 30% of the total output of gas will still be wasted.

On the other hand, we are not told about any of the by-products, such as the gas and fuel oils that could be used to great advantage at the present time, nor do we receive any information about ammonia compounds, perhaps because the price of sulphuric acid is so high.

We are told that the total cost of plant would be $366,534, but we are not told what this cost covers, whether we can only procure gas for this amount, whether we can get tar in addition, or whether we are to be provided with benzine, toluene, naphthalene, anilin, etc.

Detailed Figures Wanted

Detailed figures are not supplied as to the final cost per ton of the carbonized residue, nor as to any of the following: Cost of material and supplies for briquetting, apart from carbonized residue; labor in connection with briquetting; briquetting breakages; fixed charges.

The sum total of the information supplied is:—

(1) That large supplies of lignite slack mixed to a greater or less degree with clay, black-jack and other impurities are to be lumped together at a central plant, these various lignites differing considerably on analysis.

(2) That the freight charges alone, not to mention the additional cost of handling on a large part of these sup-

plies, amounts to about 60c. per ton, so that the fixed cost of the briquettes is to be needlessly increased from $1 to $1.20 per ton.

(3) That, as large quantities of lignite cannot be stored, the plant would be operated chiefly in the winter months, the time lignite can be used quite well in its raw state.

(4) That a large part of the gas produced at this excessive cost would be wasted.

The $400,000 Appropriation

I have been told that $400,000 is to be supplied by the government for briquetting purposes,—$200,000 by the Dominion Government and $100,000 by each of the provinces of Manitoba and Saskatchewan. I am greatly interested, as are many others, in seeing that this money is not wasted and that thoroughly sound information shall be forthcoming from this large expenditure. Personally, I am quite satisfied that any expenditure along the lines suggested by Mr. Dick would be almost entirely wasted. It is solid fuel that we want, at a reasonable cost, and not gas that cannot be utilized. I would respectfully suggest that before the expenditure of one cent of this $400,000 takes place, a much more practical and thorough examination be made into all the circumstances of the case, then if conditions warrant, install a small plant with one or two vertical retorts of commercial size instead of eight or ten, but located right at the mine from which the raw material is obtained.

At comparatively small cost we should then be able to procure the fullest possible information on a commercial basis, after which it will be time enough to go in for the larger expenditure. I quite agree with Mr. Dick that the waste of lignite slack is very great and that it could be saved by carbonizing and briquetting; I maintain, however, that briquetting slack and run-of-mine lignite in the summer time is infinitely more important than during the winter months, as by that means lignite mines could be successfully operated throughout the year, but that a far larger output of lignite in its raw state is infinitely more important than either at the present time.

Means to Procure a Plant

Up-to-date methods of producing lignite in large quantities at a low cost per ton is the most important consideration of all; next comes the manufacture of a briquette that will not disintegrate; and lastly the installation of a by-product recovery plant. I think I can safely say that for half the amount the governments propose spending, I can procure a plant that will turn out as good an article and in larger quantities, and I mean to do it; but even so, a large outlay is required, and I straightforwardly confess that I would prefer to see Manitoba and Saskatchewan going much more fully into the question than they have already done before subscribing their share of the $400,000.

If the government could be induced to admit a briquetting plant duty free, to cut down the duty during war time on mining equipment and to take in hand the foreign labor situation in a reasonable way, the solution of the coal situation would be very appreciably nearer.

I am personally very optimistic and firmly convinced that the briquetting problem will be solved in the very near future, but on lines entirely different to those suggested by Mr. Dick. There will be no wasted gas and the cost per ton will be ever so much lower.

JOHN. O. NEWTON.

Winnipeg, Man., April 15th, 1918.

TESTING WATER MAINS IN TRENCHES*

By R. O. Wynne-Roberts, M.Can.Soc.C.E.
Consulting Engineer, Toronto

ABOUT a year ago I was making enquiries as to what could be done to test water mains with air, and it may interest your readers if some of the information obtained was placed at their disposal.

John Vipond Davies, on October 6th, 1915, read a paper before the American Society of Civil Engineers on "The Astoria Tunnel Under the East River for Gas Distribution in New York City." In that paper he described how two 72-in. gas mains were tested with compressed air. The requirements were that each joint should be subjected to a test by air-pressure at 20 lbs. per square inch. Mr. Davies designed a portable machine, consisting of a double bulkhead on a wheeled frame, which could be pushed by hand through the inside of the pipe and enclose any joint within an annular space. The two bulkheads consisted of pneumatic tires inflated to make a tight joint between the testing machine and the inside wall of the pipe. The machine consisted of a cast-iron piston 71½ ins. in diameter or ½ in. less than the internal diameter of the pipe. The piston was 24 ins. long, with exterior flanges giving an annular space between flanges of 12 ins. The two flanges were designed of cove form to give close support to soft and elastic rubber tubes. These tubes were 2½ ins. in diameter, ⅜-in. rubber walls, and made of the finest inner-tube rubber, and fitted with a standard tire valve.

As the pressure to which the joints were to be subjected was 20 lbs. per square inch, it was found that 50 lbs. was ample to inflate the tubes and make an absolutely tight contact for testing purposes. When everything was ready, 20 lbs. air-pressure was applied to the annular space, and the lead joints were painted with soap and water to detect leaks, if any. Drawings and further details may be studied by referring to the Proceedings of the American Society of Civil Engineers. The pipes were afterwards air-tested at 40 lbs. per square inch and the joints were found satisfactory.

The superintendent of Louisville Gas and Electric Company (Ky.) informed me that he tested a 12-in. steel gas main by pumping natural gas into it to a pressure of 350 lbs. per square inch. This was done to ascertain if the leakage on the pipe line did not exceed one-half of 1 per cent. in twenty-four hours. The actual test covered a period of forty-eight hours, during which observations were taken at fifteen-minute intervals, gauges being read at each end of the line. Thermometers were also read for the purpose of making corrections in case of any considerable variation in temperature. This was not found necessary, however.

The pressure at both ends of the line was 350 lbs. at the start of the test, and gas was pumped into one end of the line at intervals during the test so as to maintain the required pressure, the gas supply being measured by a standard orifice meter with one ½-in. orifice in an 8-in. tube.

The superintendent stated that he believed it would have been more desirable to have made the test by pumping the line up to 350 lbs., then closing the valve and shutting the line off from the supply connection, reading the drop in pressure over a period of twenty-four hours. This method is simpler, and does not require accurate measurement of the gas supply to offset the leakage; and moreover it does not introduce waves of pressure into the line

*From "The Surveyor," London.

when supplying gas for an interval and the lessening or interrupting the supply. This was an acceptance test. During the construction, various sections were tested as laid, partly by gas and partly by air. The bellholes were not back-filled until after the test had been completed and the line found to be tight.

C. C. Simpson, the general superintendent of the Consolidated Gas Company of New York, informed me that he tested mains by compressed air, using a portable gasolene (petrol driven) air-compressor. If the mains are newly laid, and have not been tapped for services, it is only necessary to plug up both ends and make connections at one end for air and for a recording gauge. After this has been done air can be pumped in to any pressure desired. Changes in the pressure caused by changes in the volume of air in the main due to possible heating or cooling must be taken into account. It is usually the practice after the desired pressure has been secured to allow the main to stand for a while before observing the gauge for leakage.

Under 100-lb. pressure leaks should be apparent, if the main is uncovered, by the noise of the escaping air, but if not then apply a wash of soapsuds. The question as to the standard of permissible leakage is a hard one to answer. If the test is made at 100 lbs. per square inch, for the reason that this is the working pressure, Mr. Simpson considers that the main should be made absolutely tight at that pressure. If, however, the test is to more easily detect leakage, the pressure could be reduced. 100-lb. air pressure is a very severe test to apply to a main. He stated that if he was a contractor he would prefer to have his work tested under 100-lb. water-pressure rather than the same air-pressure. Gas mains in Pittsburg, Pa., are tested by compressed air, and the amount of leakage estimated by the drop of pressure in a given time.

As I was associated with the construction of a few miles of water mains where it would be inconvenient to obtain water to test them, I drafted a clause which permitted the contractors to apply either air or water. The clauses read as follows: "The pipes and connections shall be tested either hydraulically or by compressed air, by and at the expense of the contractor. When the hydraulic test is applied the leakage of water shall not exceed one Imperial gallon per hundred lineal feet of joint in two hours under a static pressure of 100 lbs. per square inch. The contractor shall make his own arrangements for a supply of water and to establish the static pressure. Or, if a compressed air test is applied, then the pipes and connections shall be charged with air at a gauge pressure of 45 lbs. per square inch and the leakage shall not cause the gauge pressure to fall more than 15 lbs. per square inch in two hours from the time when the required pressure has been established and the supply of air cut off. Allowance shall be made in this test for changes in temperature and pressure." The contractors evidently preferred the hydraulic test, because they were more accustomed to it. Circumstances, however, arose, owing to the conditions caused by the war, that prevented the specials and hydrants being supplied on time; consequently the test when applied extended throughout the whole section and under working pressure. The hydraulic test, nevertheless, was applied in certain smaller sections with the result that the leakage was slightly more than that specified.

Work on the development of power on the Nipigon River may begin before the end of the month.

St. Thomas city council has decided to appoint C. J. Macdonald, at present in St. Paul, Minn., gas works, as the superintendent of the city's gas plant.

LIQUID CHLORINE TREATMENT INEXPENSIVE

Cost of operation of two liquid chlorine plants is summarized in a recent technical paper of the New York State Department of Health, prepared by C. M. Baker, assistant engineer, Division of Sanitary Engineering. The figures show the approximate cost of apparatus, maintenance and operation of the plants at Hudson Falls, N.Y., and Westfield, N.Y., as follows:—

HUDSON FALLS

Apparatus—		
Chlorinator	$400.00	
Apparatus for testing B. coli	25.00	
Incubator	10.00	
Total	$435.00	
Yearly cost, interest at 5 per cent.		$21.75
Operation—		
Chlorine, 100 lbs., at 9½ cts.	$ 9.50	
Freight	1.05	
Trucking	.50	
Total	$ 11.05	
Yearly cost based on treating 600,000 gallons per day with 3 parts per million of chlorine		60.44
Maintenance per year		15.00
Total yearly cost		$97.19
Cost per 1,000,000 gal. water treated..		0.44

WESTFIELD

Plant—		
Apparatus	$450.00	
Building	125.00	
Stove	10.00	
Total	$585.00	
Yearly cost, interest at 5 per cent.		$29.25
Operation—		
Chlorine, 100 lbs., at 17½ cts.	$ 17.50	
Freight	.65	
Cartage	1.25	
Total cost of chlorine per 100 lbs...	$ 19.40	
Yearly cost of chlorine based on treating 1,000,000 gallons per day with .3 parts per million of chlorine		177.00
Attendant per day		100.00
Oil for heater		20.00
Maintenance per year, estimated		20.00
Total yearly cost		$346.25
Cost per 1,000,000 gal. water treated..		0.95

At Hudson Falls the plant is located in the pumping station and is attended by the engineer, thus eliminating the cost of the building, heating and attendance, while at Westfield the plant is two miles in the country and a new and separate building had to be constructed to house the apparatus. The other item of difference in cost is chlorine. With the cost of chlorine the same at Hudson Falls as at Westfield, *viz.*, 17½ cents per pound, the total cost per 1,000,000 gallons of water treated would be $0.64 instead of $0.44.

Thomas Adams, the town planning engineer, of Ottawa, is expected in Vancouver, to assist the town planning section of the civic bureau of the board of trade in preparing a Town Planning Act for British Columbia. This act will likely be passed by the provincial government during the present session.

ESTIMATING CONTRACTORS' OVERHEAD COSTS IN SANITARY SEWER CONSTRUCTION*

By Stanley D. Moore
Waterloo, Iowa.

A SEWER system, successfully constructed, might be described as one that properly meets the present and immediate future needs of the community, conceived and designed by an engineer who is competent, and whose remuneration is commensurate with the service he should render; built by a competent and responsible contractor, under a contract that is fair to all concerned, and at a price that makes it possible to carry out the intent and spirit of the undertaking without friction or litigation. Many projects will not come under such a classification. The fault is not all with the contractors, nor all with the engineers, or the communities, but each contributes its share.

Trouble could largely be avoided if each of the elements mentioned would recognize that their interests are mutual, and if the work was undertaken in a spirit of co-operation instead of the too often prevailing attitude of antagonism.

There has been too much secrecy on the part of contractors, lack of frankness and a failure to give real information; too much suspicion on the part of communities, and a regrettable lack of consideration of the rights of the contractors by both engineers and communities. There has been too much guessing as to cost on the part of both contractors and engineers. It has been customary among engineers to figure costs of labor and material, taken from actual observation, plus 10 per cent. as a basis for estimates. Contractors being a little closer to conditions have been adding 15 to 20 per cent. to such costs. Hence the usual discrepancy between the engineer's estimate and the bids received. I say usual, because for the present I wish to ignore the ridiculous bids of irresponsible and uninformed contractors, and the misguided efforts of responsible men who feel it their duty to meet such competition. Responsible engineers should not allow contracts to be let below their estimate. They should be broad-gauged enough to know the fallacy of attempting to get something for nothing and should protect the community from inevitable trouble.

Recently the Federal Trade Commissioners conducted an exhaustive study of corporations in the United States and made the astounding discovery that less than 5 per cent. of them were profitable. A similar study of the business of engineering and contracting would show that less than 1 per cent. of those engaged are successful, or even solvent, and the answer to all this is "Overhead."

Overhead is very deceptive, because in this age of quantity production we have kept our eyes only on the lessened cost of the actual operation, and have forgotten that much of this saving is eaten up in overhead charges that did not formerly exist. That is why the price of commodities regulated by the government after scientific study of cost is usually raised, or at least established on a higher basis than the prevailing level.

I have here an analysis of overhead charges taken from a compilation of actual records during the last five years of $500,000 in sewer contracts, running better than the average in soil conditions, at better than the average price, handled with better than the average efficiency, by a well-equipped, well-financed and well-organized concern. I have purposely omitted the year 1917 from these records, because of unusual conditions and extra expense that would increase these overhead costs so much as to destroy their value as a record of average conditions.

*An address delivered before the 30th annual meeting of the Iowa Engineering Society.

In Table I. I have divided the overhead costs on one-half million dollars worth of sewer work and have predicted the probable increase in these costs for the year 1918. I should like to explain these items as follows:—

Job Expense: This is the cost of freight on equipment, miscellaneous drayage, the transportation of men, the expense of lost time for men receiving steady pay, the cost of bunk houses, storage and job office rent.

Maintenance: Getting the job ready for acceptance after the main construction is completed, and daily cost sheets stopped; care of streets and trenches; repairs under guarantee.

Plant Repairs: The cost of repairs to machines and equipment, small tools and repairs, cost of tools lost and stolen, blacksmith repairs.

Table I.

Based on contract price which turned out to be gross cost, as business yielded no net profit.

Items of overhead.	Average cost for 5 years. Per cent.	Estimated cost for 1918. Per cent.
Job expense	1.4	1.7
Maintenance	.6	.6
Plant repairs	1.5	1.8
Small tools and repairs	1.1	1.3
Depreciation	1.0	2.0
Incidental material	2.4	2.4
Bonds	.7	1.7
Insurance	1.6	1.9
Interest on jobs	1.1	1.3
Discount	1.0	2.0
Promotion expense	1.8	1.8
Office expense	.6	.7
Salaries	2.3	2.3
Traveling expense	1.3	1.5
War tax	..	.5
Interest on investment	..	.5
	18.4	24.0

Depreciation: This is a cost that every contractor has on his machinery and equipment and this item should be doubled at least to meet average conditions.

Incidental Material: This item represents the cost of lumber, jute, dynamite, coal, gasoline, kerosene, cement sacks that are lost, rubber boots, etc.

Bonds: This item represents the cost of surety bonds, the rate for which is high because so many bond companies have had to finish contracts for bidders who did not know how to estimate.

Insurance: This item represents the cost of workmen's compensation and public liability insurance, and will likely increase very materially every year.

Interest on Jobs: This is not interest on investment, but interest only on money borrowed to carry on construction.

Discount: This item should be five times as much as it is to meet the average conditions of the average contractor, but as this is a true record of actual costs of one firm it is thus set out, and is probably a much smaller amount than can be shown by any other contractor doing business in this territory.

Promotion Expense: This item covers the expense of promoting jobs, dues to associations, etc.

Office Expense: This item represents postage, telephone and telegraph bills and other expense of a like nature that every business must pay.

Salaries: This item is entirely too small to cover average conditions and is only intended to represent a very small salary drawn by the head of the firm who is sole

owner of the business and gives his entire time to same. It probably should be called expense rather than salary.

Traveling Expense: This item represents the expense of traveling to bid on jobs that you do not get, the expense of trips to jobs under construction, and the many trips necessary to the town after the work is completed in order to get final settlement.

War Tax: This item must be a part of all estimates for 1918 and represents not only tax on any profits, but on postage, telegrams, telephone and freight bills.

Interest on Investment: This item must be a part of all estimates of cost. Even the Tax Department of the government admits it is a legitimate cost.

With these proven figures for overhead and assuming that we have accurate data on quantities and costs of material and labor, there remains in an estimate but the one item, "profit."

Bearing in mind that a portion of the "profit" must necessarily be represented by investment in equipment on a reasonable basis of depreciation, what is a fair profit? The accepted basis is 10 per cent. That means that on a contract for $100,000 there should be a profit of $10,000, even though a portion of this is represented by equipment. I do not think this is enough to cover the hazards involved, but for purpose of illustration we will use it.

In almost all lines of business except the construction business all computations are made back from the selling price and not up from costs. As it seems necessary for us to work on the net cost of labor and material as a basis, we must make adjustments of percentages to produce the same result.

Table I. shows that "Overhead" for 1918 is 24 per cent. of gross cost. Then the net cost of labor and material was 76 per cent. of given cost; 24 per cent. equals 31.7 per cent. of 76 per cent. Or, in other words, using net cost as a basis the overhead charge is 31.7 per cent. of the net cost of labor and material.

In order to yield 10 per cent. net on the contract price the following computation must be used, although an engineer would express the same thing in an algebraic formula:—

Table II.

	Per cent.
Net cost of labor and material = ...	100.00
Overhead 24% of 76% of given cost = ...	31.7
Gross cost percentage of net cost = ...	131.7
10% of $\frac{100}{90}$ of 131.7 = ...	14.7
Contract price percentage of net cost of material and labor	146.4
Contract price to yield 10% net = net cost plus 46.4%.	

But a contractor cannot afford to do business on a 10 per cent. margin for the reason that an increase of 10 per cent. in labor cost which is as close an estimate as can be made, and which is many times unavoidable, is enough to wipe out his entire profit. He cannot afford to figure less than 15 per cent., which means adding 53 9/10 to his net cost instead of 46 4/10.

The following list of items all enter into the cost of building sewers and I have starred those which the contractor usually takes into account in making up his figures, but many items remain, all of which he must pay for, but which he fails to get into his estimate:

*Sewer pipe	*Labor
Jute	Bad weather
*Bonds	Freight on tools
*Insurance	Straight time
City council	Storage
Cement	*Discount
Tools	Lumber
Inefficiency	Repairs
Depreciation	Shipping delay
Interest	Office expense
Errors	Manholes
Salaries	Drayage
Bad work	*Association dues
Attorneys' fees	Promotion expense
Taxes	Bad luck
Transportation	Traveling expense
Engineer's errors	Hope
Engineer's delays	Water pipes
Engineer's estimates	Gas mains
Maintenance	

The question of "Overhead," while perhaps a recent development, is just as sure as "death or taxes." No contractor can get away from it.

He may be able to save on a few of the items but will go wrong on others. If he looks only at the saving, he is hiding his head in the sand. Many items of overhead have recently increased from 50 to 300 per cent. That is why many contractors have gone wrong, who have their overhead included in their estimating tables and have figured increased cost on a general percentage. This charge for overhead may seem high, but it is not, compared with similar commercial enterprises. For instance, the manufacturing business is similar to the contracting business. They take material and labor and sell a finished product and the average cost of overhead and selling expense in manufacturing is 70 per cent. over the factory cost. The retailer who has no labor to contend with has an established overhead of 20 per cent., but no contractor can hope to equal such figures. Furthermore, the contractor's rate of turnover is slow and below the average.

To better his condition the contractor must first confer with the engineer. As a class, the engineer is not unreasonable and is open to conviction, and the contractor must show him frankly the whole situation and convince him of his mistakes in estimating. A number of engineers have recently told me that they had never been able to get any real information from contractors, and would be glad to have a basis to work from.

The next trouble is with the communities, although they usually get their ideas from the engineers. If the price is too high, let them wait until they are ready to pay it. That is what other business men do, and it is better to let the job wait than to do it for nothing. Every community is better off if they pay a fair price and get a good job satisfactorily executed than if they try to get something for nothing and get skinned.

The irresponsible competitor is another factor that often originates with the engineer, who many times has a mistaken idea that the contractor is making a lot of money, and who therefore encourages some inexperienced person to enter the field of competition. It is unfortunate that engineers are not compelled to do two years of contracting before they are allowed to practice their profession. They then would not get wrong ideas in their heads, and would not spend a lifetime trying to prove that their first impressions were right. Many methods of overcoming unreliable competition may suggest themselves; none of which, however, justify the wrong idea that a contractor had better do work, even if there is nothing in it, than to be idle.

The last and greatest trouble is with the contractor himself. Let him get out of the old rut and start estimating properly, discarding all his old estimating tables, retaining only his records of labor, and material cost, for his first basis in estimating, making proper allowance for increases in wages and material, and the ever-decreasing efficiency of labor; then include a proper percentage for overhead and profit.

Committee on Prestige Offers Resolutions

Members of the Toronto Branch of the Canadian Society of Civil Engineers Meet To-night to Adopt, Amend or Reject Nine Resolutions Tending Toward Improvement in the National Status of Engineers

THE following nine resolutions have been prepared by the Committee on Prestige of the Toronto Branch of the Canadian Society of Civil Engineers, and will be discussed at a meeting to be held this evening at the Engineers' Club, Toronto:—

1.—That the Ottawa Branch be invited to co-operate with the Toronto Branch in the drafting of a bill for the restriction of the employment of engineers upon public works, such as federal, provincial and municipal works, to those who have conformed to the requirements which shall be defined therein; and such draft, after being approved by the respective branches, to be submitted to the council of the Institute for consideration and action.

2.—That legislation be obtained forbidding the expenditure of public funds upon the construction of bridges, roads, docks, harbors, waterworks, sewerage and sewage works, electric light and power works and other undertakings, unless the plans for the same shall have been prepared by and the supervision is under the control of engineers who have conformed to the requirements defined in the proposed draft bill mentioned in Resolution No. 1.

3.—That it is desirable that the branch shall make provision for the payment of the branch secretary, and that it shall be deemed part of his duty to keep in close touch with the members and to render every assistance for their professional advancement.

4.—That the council of the Institute be asked, in order to secure material for further discussion, to issue an enquiry to the members generally to ascertain the compensation received by engineers of various ages and in different classes, and employed in various technical services, and that steps be taken, if possible, to ascertain also the compensation paid to men of corresponding ages, classes and services in other professions.

5.—That the council be asked to organize a scheme for the defence of members who have been attacked in the performance of their professional duties on what may appear unjustifiable grounds.

6.—That the technical work of the Institute can be most successfully carried on by means of technical sections to which shall be entrusted the organization of ordinary meetings, special sectional conventions, etc.

7.—That the executive committee be requested to consider the suggestion of holding weekly or fortnightly lunch meetings, at which addresses will be delivered and facilities given for the members to become better known to each other. Such practices as obtain at meetings of the Rotary or the Electrical Clubs might be followed.

8.—Whereas in the vocation of engineers, technical knowledge is necessarily of primary importance, that the council be asked to adopt every means in their power to make transactions of the Institute a complete record of Canadian engineering achievements and of Canadian engineering studies.

9.—That it is desirable to appoint sectional technical committees who shall undertake special studies and investigations to be assigned to them. The appointments to such committees to be made only after formal acceptance of office by the nominees, and the work of the technical committees to be carefully supervised by the executive committee. In the case of appointees failing to carry out the work, the executive shall, after due notice, request their retirement and elect others in their places.

TWO ENGINEERS TO LOSE POSITIONS?

Unless some further influence is brought to bear upon the city of Vancouver, B.C., two of the three engineers who are now department heads in the city's employ will be discharged in the near future. The city council has unanimously adopted a recommendation that the city engineer, F. L. Fellowes, be instructed to dispense with the services of any two of his three present assistants, merely in order to economize in the engineering department.

The three engineers concerned are A. G. Dalzell, in charge of sewers; Chas. Brakenridge, in charge of paving; and E. M. Le Flufy, in charge of waterworks.

At the council meeting a letter was read from E. G. Matheson, vice-chairman of the Vancouver Branch of the Canadian Society of Civil Engineers, protesting against any reduction in the city's engineering staff, and urging that "a strong staff be maintained and its time and energy devoted to planning for the future growth of the city, to the end that its development may be along economical lines and its sanitation and beauty be safeguarded."

The reduction in the city's engineering department was one of the planks in Mayor Gale's election campaign, and he has persistently advocated a reduction of the engineering staff from four to two.

AMERICAN SOCIETY OF M.E., ONTARIO SECTION

A meeting of the Ontario Section of the American Society of Mechanical Engineers was held at 8 p.m. April 18th, at the Engineers' Club, Toronto. Professor Angus presided and the local members and a number of visitors and prospective members were favored with a very interesting paper on "Heat Treatment of Low Carbon Steels," by W. M. Wilkie, of the steel department of the Imperial Munitions Board.

The discussion that followed the paper bore principally on the troubles encountered by the producers and users of shell steel. Among the engineers present were a number of those connected with local munitions plants, and their remarks were based on actual experiences and the solution of various troubles under war-time conditions.

Before the paper was read, the meeting appointed W. P. Robinson, of the Northern Crane Works, Limited, to be chairman of the committee on increase of membership, re-appointed the secretary, C. B. Hamilton, as delegate to the Joint Committee of Technical Organizations (Ontario Branches), and appointed a nominating committee of two, Messrs. Flettemeyer and Ward, to prepare a slate for the election of section executives which will take place by letter ballot within the next few weeks.

The Engineer's Library

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer, 62 Church Street, Toronto

RELIEF FROM FLOODS

Reviewed by W. H. Breithaupt, C.E.
Kitchener, Ont.

By John W. Alvord and Charles B. Burdick. Published by the McGraw-Hill Book Company, Inc., New York. First edition, 1918. 175 pages, 22 tables, 54 figures, 6 x 9 ins., cloth. Price, $2 net.

In the past number of years there has appeared a large bulk of literature on the question of flood relief. The exhaustive report of the Pittsburg commission on regulation of the Allegheny and Monongahela rivers in 1911, numerous reports of State commissions, notably the New York State reports since 1913, the Ohio flood reports, and many others. This book, while giving more attention to the Ohio problems, is a general compendium, aimed somewhat at the general public, but a good book for the engineer. It has good illustrations and instructive diagrams and tables.

The frequent reference to Ohio floods the authors frankly explain on the ground that this is their particular field. The enormous flood losses in the United States since 1900 are emphasized and particularly those in Ohio. Factors affecting stream flow and floods are precipitation, character of water-shed and climate. The wide variation, depending on topography and condition of surface, on subsoil conditions and on saturation of the ground, is discussed.

Forestation, while no doubt of not much effect in many cases, is rather underestimated by the authors as to its effect on particular rivers as combined with topography and climate; as, for instance, with snowfall in northern climates.

In chapter 2, means for flood relief are discussed. These consist of flood prevention, flood protection, and flood diversion. In the United States no large detention basins have so far been built primarily for flood protection. There are many for conservation of municipal water supply. A detention basin is defined as a dam across a river valley having in its base an opening large enough to pass the channel capacity of the river below it. River control by means of levees is an old practice, as are also dykes protecting low lands on the sea-shore. The French were practically first in Europe in the art of river control by storage. Two dams on the Loire date from 1711. In Germany and Austria such work has been particularly extensive since 1900. A table is given of storage dams in France, Germany and Austria. The largest artificial storage reservoirs in Europe are in Russia, on the Volga and Meta Rivers. There are also considerable works of this kind in Spain. In the United States the largest capacity reservoirs are those on the headwaters of the Mississippi River, with capacity of 96 million cubic feet. These reservoirs have been effective in improving the low-water stage at St. Paul by 14 inches. The Ottawa River water storage, still under way, will be of larger capacity, and less cost than that on the Mississippi. A table is given of recommended reservoirs on the Allegheny and the Monongahela water-sheds.

In the Ottawa River project, and again in tables, pp. 133 and 153, reservoir capacity is given in acre-feet. The term "acre-feet" pertains, properly, to irrigation projects only. As applied to storage capacity in general this term is involved and to that extent confusing.

Chapter 3 discusses flood investigations and the importance of comprehensive exposition to the public.

Chapter 4 further discusses flood investigation, under three heads—Values and Losses, Topographical and General Physical Condition of the Water-shed, and Hydrology; annual flood losses, what territory can be profitably included in a protection project, rainfall records and stream flow, rating curves, etc. The Ohio River is in the path of most of the great rainstorms in Central North America.

Chapter 5 treats of probable magnitude of greatest floods to be provided for in relief works, discusses Kuichling's data and formulæ and the comparison ratios suggested by W. E. Fuller. A map of the United States is given showing mean annual flood coefficients.

In Chapter 6 flood protection by channel improvement is considered, under the methods of levee construction and channel betterment, and by cut-offs. Any such channel improvement delivers the water more rapidly to the river below and is therefore to that extent objectionable. In channel improvements it is necessary to observe the limiting velocity, to prevent scour. The protection afforded by sod on flooded areas is illustrated, and varieties of channels and conduits are discussed.

Chapter 7 deals with flood prevention by water-storage, distribution of stream flow, incidental storage, and storage for floods; the location and required capacity of flood reservoirs; detention basins and their automatic operation, spillways, outlets and drift barriers. The Dayton detention basins and the proposed works for the Scioto River are described. A final conclusion is that local conditions must govern the particular type of relief best adapted.

An appendix gives a comprehensive and valuable table of great floods in the United States, with record period of from 10 to 70 years, drainage areas, maximum and average annual floods and their ratios.

The book has a good index.

WHAT INDUSTRY OWES TO CHEMICAL SCIENCE

Reviewed by L. J. Rogers
Canadian Inspection and Testing Co., Toronto

By Richard B. Pilcher and Frank Butler-Jones. Published by Constable & Co., Limited, London. 150 pages, 5 x 7½ ins., cloth. Price, $1 net.

The authors deal with the great advancement made in industry in the last century, and indicate the manner in which chemistry has brought about changes. Possibly the most noteworthy of these are the steel and dye industry. "Experience accumulated slowly and at great cost had done great things, but the rate of progress in industry developed in the past century defies comparison with all the centuries combined since time was—so far as we know."

This book is readable to the layman and will give a comprehensive view of the value of the application of chemistry to most any manufacturing business.

To the student it is concise history of scientific advancement during the last century.

RAILROAD STRUCTURES AND ESTIMATES

Reviewed by J. R. W. Ambrose
Chief Engineer, Toronto Terminals R'y. Co.

By J. W. Orrock, M.Can.Soc.C.E. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. Second edition, 1918. 574 pages, 272 figures, 6 x 9 ins., flexible binding. Price, $5 net.

The author has covered the field so thoroughly that the work is invaluable to the experienced engineer as well as to the student, and every superintendent would do well to keep a volume in his office bookcase for ready reference.

To make an exhaustive review of this work would require more space than is at my disposal. It will suffice to say that there is no department of the construction and maintenance of railways that is not covered. The book is so profusely illustrated with detail drawings and estimates that even the comparatively inexperienced is enabled to check or design railway structures of all kinds.

Estimates of costs are given in all cases, and while these are based upon pre-war prices, they can easily be changed to suit local conditions.

The formulæ given for estimating the cost of steel and wooden bridges are new and based upon actual experience, making them of exceptional value.

The work really embodies a complete set of railway standards which has required years of experience to formulate.

MECHANICAL LABORATORY METHODS OF TESTING MACHINES AND INSTRUMENTS

Reviewed by Prof. Robt. W. Angus
University of Toronto

By Julian C. Smallwood, M.E. Published by the D. Van Nostrand Co., New York. Second edition, 1918. 399 pages, 5 x 7½ ins., 114 illustrations, flexible leather. Price, $3 net.

This is the second edition of a very useful and practical book for use mainly in engineering laboratories, although it contains many things that will prove of value to the practicing engineer. The author has divided the treatment of the subject into three parts, *viz.*, the testing of instruments, the analysis of combustion and the testing of power plant units.

The testing of instruments deals with a most useful, and too-frequently neglected, matter—the calibration of the scales, gauges, indicators, planimeters, etc., and the author has covered very fully and completely the ordinary instruments used.

The section on combustion is rather short but deals with useful matters, while under the testing of power plant units the author has discussed steam engines, boilers, pumps and other steam apparatus, gas engines, refrigerating machines and air compressors. He has devoted relatively little space to the matter of hydraulic turbines and pumps, which, however, seems consistent with the title of the book. There is practically nothing on electric testing.

On the whole, the book is very well written, and is a helpful guide in the laboratory, and will prove suggestive to the consulting engineer who is doing mechanical testing at more or less infrequent intervals.

NOTES, PROBLEMS AND LABORATORY EXERCISES IN MECHANICS, SOUND, LIGHT, THERMO-MECHANICS AND HYDRAULICS

Reviewed by Prof. Peter Gillespie
University of Toronto

By Halsey Dunwoody, late acting professor of Natural and Experimental Philosophy. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. 369 pages, illustrated, 6 x 9 ins., cloth. Price, $3 net.

This book is essentially a book of problems supplemented by various theoretical and historical notes intended to elucidate the subjects to which the problems relate. It was prepared by the author as a reference text in connection with his course in "Natural and Experimental Philosophy" at the U.S. Military Academy, and to a large extent is a compilation of notes and exercises drawn from the syllabi of several technological schools, including the Massachusetts Institute of Technology and the Worcester Polytechnic. The problems are exceedingly varied, covering as they do dynamics, machines, heat, sound, light, hydromechanics and graphic statics and should afford an excellent field for selection for those entrusted with the teaching of those subjects in engineering schools. The theoretical treatment is generally brief but adequate.

TESTING FOR THE FLOTATION PROCESS

Reviewed by F. C. Dyer
University of Toronto

By A. W. Fahrenwald, Professor of Mining and Metallurgical Engineering, New Mexico State School of Mines. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1917. 173 pages, illustrated, 4¼ x 6¾ ins., flexible binding. Price $1.50.

This book is a convenient and compact resumé of the latest ideas concerning flotation. Before describing the laboratory tests and apparatus the author gives enough of the theories and fundamentals of the various processes to make the actual testing intelligible. The part concerning colloids and emulsions is well written, leaving out a lot of unnecessary phraseology and ambiguous terms. The chapter on oils will be found useful, much of the success or failure of flotation being due to a choice of oils. The chapters on oxidized ores, flotation costs, and tables help to complete a book that will be found very handy for anyone engaged in flotation practice.

DIFFERENTIAL AND INTEGRAL CALCULUS

Reviewed by Prof. Alfred Parker
University of Toronto

By H. B. Phillips, Ph.D., Massachusetts Institute of Technology. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. 356 pages, 5 x 7¼ ins., cloth. Price, $2 net.

The lines along which an elementary text-book on the calculus should proceed are fairly definite, almost as much so as is the case with text-books on elementary algebra. Dr. Phillips' book will be found an excellent work for use in classes. There is great clearness of treatment, important parts of the subject are properly accentuated and parts of minor consequence are left where they should be. There is a great wealth of practical examples and problems for the student to work, with the result that the student who follows Dr. Phillips' treatment will realize how intimately the infinitesimal calculus is associated, one may almost say, with the affairs of everyday life. Very properly, a chapter on different equations has been introduced as a continuation of the work on integration.

ELEMENTS OF SANITARY ENGINEERING

By Mansfield Merriman, M.Am.Soc.C.E. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. Fourth edition, 1918. 250 pages, illustrated, 6 x 9 ins., cloth. Price, $2 net.

This useful volume has been revised and brought up to date with the assistance of Richard M. Merriman, Assoc. Mem.Am.Soc.C.E. and assistant engineer of MacArthur Bros. Co., New York.

Like the previous editions of this work, it is primarily intended for the use of students, and at the end of each chapter are given exercises and problems which require that the student shall consult encyclopedias, books and engineering literature in order to obtain details of special topics.

Since the publication of the first edition of this book in 1898 many important advances in sewage disposal have been made. Accordingly, the chapter dealing with sewage disposal has been rewritten and expanded. The articles on the Imhoff tank and the article on the other methods of sewage purification are new matter. Fourteen new pages of text have been added and a number of new problems and exercises introduced and several sections have been entirely rewritten.

PUBLICATIONS RECEIVED

Estimates for the Fiscal Year Ending March 31, 1919. Federal Government, Canada. Sessional paper 3. Price, 5 cents.

Temiskaming and Northern Ontario Railway Commission.—Annual report, 1917. Ontario Government Railway.

Records of Scientific Literature.—November to December, 1917. Published by D. Van Nostrand Company, 25 Park Place, New York City.

Electrification of Railways.—By S. T. Dodd, General Electric Company, Schenectady, N.Y. Issued by the Commission of Conservation, Canada.

Nox-Aer-Leek.—Pamphlet on the uses and application of this cement. Issued by the Barrett Company. Prepared by the Erickson Company, New York.

The Niagara Power Shortage.—By Arthur V. White, consulting engineer, Commission of Conservation. Issued by the Commission of Conservation, Canada.

Power Possibilities on the St. Lawrence River.—By Arthur V. White, consulting engineer, Commission of Conservation. Issued by Commission of Conservation, Canada.

Tide Tables for Nelson, Hudson Bay—Also tidal data for Hudson Strait and James Bay for the season of 1918. Issued by the Tidal and Current Survey in the Department of the Naval Service of the Dominion of Canada.

Navigation.—By George L. Hosmer, Massachusetts Institute of Technology. Published by John Wiley & Sons, Inc., New York. First edition, 1918. 214 pages, 52 cuts, 4⅛ x 6⅛ ins., cloth. Price, $1.25 net.

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Manitoba Hydrometric Survey.—For the calendar year 1916. By M. C. Hendry, A.M.Can.Soc.C.E., chief engineer. Water Resources Paper No. 22. Dominion Water Power Branch, Department of the Interior, Canada.

Comparative Tests of Six Sizes of Illinois Coal on a Mikado Locomotive.—By Edward C. Schmidt, John M. Snodgrass and Otto S. Beyer, Jr. Bulletin No. 101, published by Engineering Experiment Station, University of Illinois, Urbana, Ill. Price, 50 cents.

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Interests Dependent on Winnipeg River Power.—With special reference to the capital invested and the labor employed. By H. E. M. Kensit, M.Am.Inst.E.E., M.Can. Soc.C.E. Water Resources Paper No. 20, Dominion Water Power Branch, Department of the Interior, Canada.

A Dictionary of Aircraft.—By W. E. Dommett, A.F.Ae.S., M.I.Mar.E., A.M.I.A.E., author of "Aeroplanes and Airships," etc. Published by Electrical Press, Limited, Fisher Street, Southampton Row, London, W.C.I. New York agents, D. Van Nostrand Co., 23 Murray Street.

Creosoted Wood Block Factory Floors.—Causes and prevention of failure. Paper read by Lambert T. Ericson, contracting engineer, at convention of American Wood Preservers' Association, Chicago. Published by the Jennison-Wright Company and the Midland Creosoting Company, Toledo, Ohio.

Proceedings of the Victorian Institute of Engineers, 1917.—Containing papers and discussions on the subjects of "Training of an Engineer," "The Influence Line," "Road Construction to Stand Modern Traffic," "Gas Holder Construction," etc. Published by the Institute, 57-59 Swanston Street, Melbourne, Australia.

Steam Tables for Condenser Work.—A hand book of steam tables, with pressures below atmospheric expressed in inches of mercury referred to a 30-in. barometer; also including a discussion of the use of the mercury column, the errors in such measurements and constants for their correction. Published by Wheeler Condenser and Engineering Company, Carteret, N.J.

McAvity Marine Specialties.—Sixty-eight page catalogue, 8½ x 10¾ inches, coated paper, well illustrated, describing McAvity marine specialties to pass British Admiralty, Lloyds and Imperial Munitions Board's specifications, including marine valves, fittings, hardware, etc., used on steamers and vessels both in building and maintenance. This firm also recently published a catalogue of similar size on "World" corporation specialties, including fire hydrants, gate valves, globe valves, indicator posts, hose nozzles, sewage pumps and ornamental lighting posts.

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Principal Contents of this Issue

THE MINISTER OF PUBLIC WORKS

PATRONAGE really appears to be doomed in the Public Works Department under the direction of Hon. Frank B. Carvell, now Minister of Public Works. Contractors throughout the country will read with considerable satisfaction the official correspondence recently tabled in Parliament and subsequently published in the "Toronto Globe." On motion by an opposition member, the administration tabled correspondence between the Minister of Public Works and the Conservative-Unionist member for Ottawa, A. E. Fripp. Two months before the general election, Mr. Fripp wrote the new Minister of Public Works, asking that a certain firm in the former's constituency be placed upon the patronage list. The minister promptly replied as follows:—

"Your friends will have opportunity of tendering on any work coming within their line, but, so far as this department is concerned, there will be no patronage list in the future. As far as possible, everything will be done by public tender and contract, and every member of the community will have an equal opportunity of working for the government. Efficiency and economy will be the guiding principles in carrying on the business of the department."

Soon after the general election Mr. Fripp again wrote the minister and suggested the names of certain individuals to act as employment agents on certain public works. The minister replied immediately upon receipt of the letter, stating that he was unable to agree with the suggestions made and saying that he could not and would not have his time taken up with small matters of patronage. He advised Mr. Fripp to take the same stand. The Ottawa member replied that his purpose was merely to get rid of the fifty or sixty people who crowd his office daily, and said that the people of Ottawa have lived on patronage for fifty years, and that it would require some tact to eradicate the practice.

Mr. Carvell wrote to Mr. Fripp a week later, saying that he had given instructions regarding employment of the class of people referred to by Mr. Fripp, and stating that it would not be necessary for them to produce a letter from either Mr. Fripp or Dr. Chabot (junior member for Ottawa) or to use any other influence for the purpose of obtaining employment in the Public Works Department.

It is evident, however, that Mr. Fripp was still unconvinced that patronage had been banned, because on February 12th, 1918, he wrote Mr. Carvell asking that certain Ottawa concerns be given an opportunity of tendering for the construction of the new 700-room office building which the department proposed to build in Ottawa. In reply, Mr. Carvell wrote:—

"Every contractor, not only in Ottawa but in Canada, will be given the opportunity to tender. The contract will go to the lowest tenderer, providing the firm has the financial ability to carry out the work."

The "Toronto Globe" says that Mr. Carvell is to be congratulated upon his honest and businesslike stand, and *The Canadian Engineer* would second these congratulations. The Department of Public Works is the big spending branch of the administration, and if Mr. Carvell sticks to his announced policy of carrying out all public works honestly, impartially and efficiently, his administration of that department is likely to constitute a bright and shining spot in the Borden Government. This is particularly true if, at the same time, he really adheres to the policy which he outlined recently in a speech before the Ottawa Branch of the Canadian Society of Civil Engineers, when he said:—

"I propose doing nothing in my department except on the advice of the responsible engineers employed to give me that advice. . . . I have learned that the man who attempts to construct anything without taking the advice of technical men, is on a par with the lawyer who conducts his own case,—and I suppose you know the rest of it, he has a fool for his client. Being both a lawyer and a minister of public works, and knowing something of the consequences of not taking the best course in these matters, I have decided that so far as I am concerned, I will rely on the advice of my technical officers on all technical questions."

A CLOSED PROFESSION

IN a "Letter to the Editor" published on page 361 of this issue, C. E. W. Dodwell, of the Public Works Department, very interestingly outlines the struggles of the engineers in that department to obtain higher remuneration and some of the special privileges accorded to clerks and others but not to engineers. As a partial remedy for existing conditions, Mr. Dodwell suggests "closing" the profession. He says:—

"It is proper that membership in some one of the several classes in the Canadian Society of Civil Engineers should be required as a just and proper indispensible condition precedent to appointment in our service. . . . . Membership in the Canadian Society of Civil Engineers is the only guarantee, test, diploma or certificate that a man is a qualified engineer."

If only members of the Canadian Society of Civil Engineers were to be allowed to practice engineering in Canada, the entire procedure of admission to the society would have to be changed. Graduation from a recognized engineering course or the passing of a national board's examinations, should then *entitle* any man to corporate membership in the society, without any voting or ballot-

ing; disciplining or dismissal from membership should be solely in the hands of the same representative, impartial and carefully constituted board that conducts the examinations for admission; and nobody should ever be admitted to membership other than graduates of recognized engineering universities, those who from time to time might pass the examinations of the national board, and those who in the opinion of the national board had been clearly practising engineering for a certain term of years prior to the passing of the Act closing the profession.

Engineers differ widely in their opinion whether a closed engineering profession is feasible or practical. Many believe that it depends a great deal upon whether a satisfactory administrative or examining board could be obtained, and upon whether examinations could be devised which would be sufficiently rigorous to bar out the undesirable applicant and at the same time sufficiently broad to reveal the practical skill and knowledge of the engineer who might be well qualified along some lines and yet deficient in certain fields of theory.

PERSONALS

Major Athol H. Macfarlane, M.C., who recently received his majority, went overseas as private in the 4th C.M.R. He is a graduate of the School of Practical Science, University of Toronto.

J. B. Challies, superintendent of the Dominion Water Power Branch, was in Halifax last week in conference with the Nova Scotia Water Power Commission with regard to the investigation and administration of the water powers of that province.

Major J. Colin Kemp, M.C., who was recently appointed brigade major with the 3rd Brigade, 1st Division, has been severely wounded in the recent fighting. Major Kemp, in civil life, was a mining and civil engineer connected with the firm of R. A. Ross, Montreal.

E. L. Cousins, chief engineer and general manager of the Toronto Harbor Commission, has returned from a trip to Vancouver, where he enquired into harbor conditions and was consulted by the city engineer, F. L. Fellowes, regarding the development of the upper basin of False Creek.

Lieut. C. F. Szammers, B.A.Sc., '11, University of Toronto, who went overseas with the 2nd Canadian Pioneers, has been appointed O.C. of the Canadian Corps Tramways, Section 1, engaged in building light railways to the front line in France. Before enlisting, Lieut. Szammers was connected with the firm of Sherwood and Sherwood, Toronto.

Prof. L. A. Herdt, M.Can.Soc.C.E., E.E., Macdonald professor of electrical engineering at McGill University, recently appointed to the Montreal Tramways Commission, is also chairman of the Electrical Commission of Montreal, the representative of the provincial government on that board. Prof. Herdt was born in France in 1873, came to Canada when a boy, and was educated at the Montreal High School and McGill University, whence he graduated in the Faculty of Applied Science in the department of mechanical engineering in 1893. After a short term with the Laurie Engine Works, Dr. Herdt decided to specialize in electricity and with this in view went to study in Paris and Liege, where he graduated with first-class honors. He returned to Canada in 1900 and joined the staff of the Electrical Department of McGill as demonstrator. In 1907, he was made associate professor and in 1909 succeeded Prof. R. B. Owens to the chair of electrical engineering. In 1905, he was appointed Officier d'Academie by the government of France and in 1907 was the Canadian delegate to the International Electric Technical Commission which met in London, Eng. He was consulting engineer for the large hydro-electric development of Winnipeg in 1910, built at Point du Bois, with a transmission line of 77 miles. He was also the consulting engineer of the Montreal Electrical Commission, and of the recent Tramways Commission which made a tour through the principal cities of the United States to study methods of operation. Dr. Herdt has done much electrical research and is the author of a number of works accepted as text books throughout the continent.

CANADIAN ASSOCIATION OF ENGINEERS

The third organization meeting of "The Canadian Association of Engineers" was held last Monday evening in the Engineers' Club, Toronto, with fifteen prospective members present. In the absence through illness of Hyman A. Goldman, chairman pro tem, the chair was taken by F. B. Goedike, secretary pro tem. A committee of five members, with G. L. Berkeley as chairman, was appointed to draft a constitution and by-laws.

It was decided to meet at the Engineers' Club on the third Monday of each month, beginning May 20th. Letters from the secretary of the American Association of Engineers were read, but it was decided to proceed with the organization and incorporation of a distinctly Canadian association which would co-operate with the American association, rather than to form a branch of the latter. A publicity committee was appointed for the purpose of securing a larger attendance, at the next meeting, of junior engineers who desire to join the organization.

The chief purpose of the organization, at present at least, appears to be a concerted action toward improving the remuneration of junior engineers and toward helping unemployed members to find positions. The suggestion by Prof. Peter Gillespie, chairman of the Toronto Branch of the Engineering Institute of Canada, that the organization of the new association be deferred, pending action along similar lines by the Institute, was not favorably considered. Five of the men who were present are members or associate members of the Engineering Institute of Canada, and they expressed the hope that the Institute would take active action along these lines but did not favor abandoning the organization of the new association, at least until the Institute had accomplished something definite along the lines which will be followed by the association.

The acting chairman stated that the need for their organization would disappear and that they would disband and all join the Institute, if they should see at any future time that the Institute in Canada is accomplishing for the junior engineers what the American Association of Engineers is accomplishing for them in the United States.

AMERICAN WATER WORKS ASSOCIATION

Arrangements have been made with the Planters' Hotel, St. Louis, for holding the convention of the American Water Works Association. The meeting room, secretary's office and exhibit room will be at this hotel. The American Annex, two blocks from the Planters, has been selected as the overflow hotel. Owing to freight conditions, there will be no heavy exhibits.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Fertilizer Value of Activated Sludge

Ten Crops Show Increases in Yield Ranging Up to 554% and Averaging 179%, Using Activated Sludge as Fertilizer, Compared With Manure—Same Crops Show Increases Ranging Up to 7,137% and Averaging 1,781% Compared With Unfertilized Soil

By COL. GEO. G. NASMITH*, C.M.G., D.Sc., and G. P. McKAY†, B.A.

Department of Health, Toronto

THE most important problem remaining to be solved in the disposal of sewage is probably that of economically dewatering the sludge. Since the discovery of the activated sludge method, the necessity of devising a method of dewatering this new type of sludge has become even more urgent for the reason that activated sludge has marked fertilizing properties, as Messrs. Bartow and Hatfield have pointed out.

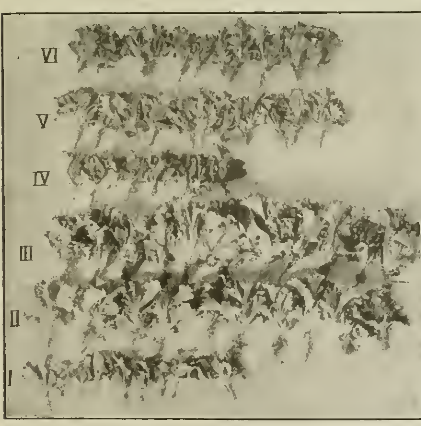
In the activated sludge method of sewage disposal, finely divided air is blown through the sewage. After some time, the sludge which settles out is found to possess remarkable properties when activated with fresh sewage by the same method of aeration. The sludge has become "activated," and when blown in contact with fresh sewage, the organic matter present in the latter is rapidly oxidized, practically all the intestinal bacteria destroyed, nitrates elaborated and a stable effluent formed.

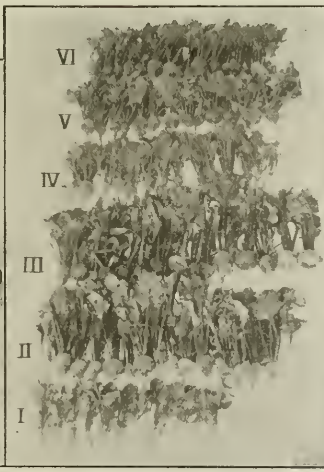
"Activated" sludge, however, like ordinary sludge, contains from 95% to 97% of water, and still has to be dewatered before it can be satisfactorily handled.

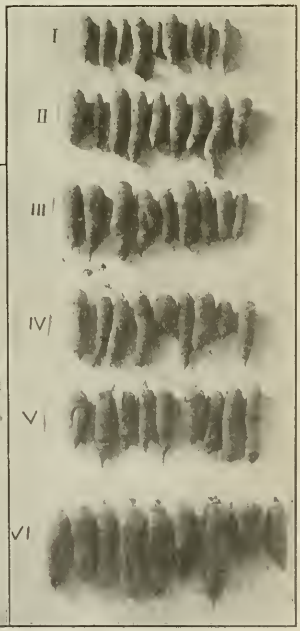
*Director of Laboratories.
†Chemist in charge of Experimental Sewage and Chlorination Plant.

The treatment of sewage by this method is a very promising one, for, if the fertilizing value of the sludge be high, the revenue therefrom would help to pay the cost of dewatering and disposing of the sludge. Furthermore, it is a question of conservation of the first magnitude, for if a fair proportion of the fertilizing value of the excreta from our cities and towns could be saved and turned back into the land, it would be a great factor towards solving our fertilizing problem, particularly in conserving the supply of humus and nitrates and increasing the fertility and productivity of the soil.

In December, 1915, a small experimental activated sludge plant was started at the Toronto Main Sewage Disposal Works, Morley Avenue. Dr. Adams and J. Scott, who at first operated the plant during Col. Nasmith's absence in France,







Specimens of Experimental Crops Grown to Determine Fertilizer Value of Activated Sludge

Lettuce at the left, beets in the centre, carrots at the right. No. 1 in each case was grown in unfertilized soil; No. 2, using barn-yard manure as fertilizer; No. 3, using activated sludge; No. 4, septic sludge from old bed at Morley Ave., Toronto; No. 5, humus from brush filter, North Toronto; No. 6, sludge from North Toronto tanks

soon proved that Toronto sludge could be readily activated, and the plant has been in operation ever since. A good deal of preliminary data has been obtained for our own information in case the city of Toronto should ever decide to adopt the method on a large scale. Among other things, we have tested the value of activated sludge as a fertilizer.

Bartow and Hatfield*, in some experimental work to determine the value of activated sludge as a fertilizer, made a number of experiments with the growth of wheat in pots. The activated sludge used by them gave the following analysis:—

Total nitrogen	6.3 %
Phosphorus (P_2O_5)	2.69%

By the use of one ton of this sludge per acre, equivalent to 120 pounds of nitrogen, in combination with five tons of dolomite, one-half ton of bonemeal, and 500 pounds of potassium sulphate per acre, they obtained a yield of 36 to 37½ bushels of wheat per acre as against 13½ bushels per acre where the equivalent amount of nitrogen had been added in the form of dried blood. The straw also amounted to over two tons per acre as against less than three-quarters of a ton of straw per acre where dried blood had been employed as fertilizer.

In further tests as to the value of sludge as a market garden fertilizer, these investigators used plots, each 2 ft. x 3 ft., which were treated with equivalent quantities of sludge and dried blood per acre. They obtained an increase in weight of 40% in the lettuce and 150% in the radishes, and the growth was much more rapid in the beds fertilized with activated sludge. They conclude from their experiments "that the nitrogen in activated sludge is in a very available form, and that activated sludge is valuable as a fertilizer."

Bartow and Hatfield, in determining the amount of fertilizer to be employed, used as a basis the amount of nitrogen present. For instance, they used in their experiments the quantity of activated sludge and dried blood that would yield 120 pounds of nitrogen per acre. The amount of phosphate or other ingredients present in the sludge was not considered.

The Value of Fertilizers

Experience has proven that the value of fresh manure as a crop-producer is from one-third to two-thirds more effective than rotted manure, because a certain proportion of nitrogen and other ingredients have been leached out of the latter and lost. Manure has a greater fertilizing value than would be estimated from the amount of nitrogen, phosphoric acid and potash present. This greater value is due to the large amount of humus present in the manure; humus is not found to any extent in the commercial fertilizers, which are commonly purchased on their nitrogen, phosphoric acid or potash content.

Humus is partly decomposed organic matter, such, for example, as decayed leaves. It is found in large quantities in all fertile soils and is probably the most valuable constituent present, because it is not only a source of nitrogen, but it helps to keep the soil moist, loose and well aerated, as well as to provide a medium for the propagation of soil organisms so essential to the growth of plant life.

The chemical constituents in a fertilizer are not the only ones upon which its fertilizing value must be determined. It would be possible to have the same amount of potash, nitrogen and phosphate in two different fertilizers and yet obtain entirely different results upon plant growth. The availability of the food material for the assimilation of the plant is a great factor. Thus ordinary septic sludge is not a good fertilizer for immediate growth of plants, results obtained the first year being poor. But the transformation of the septic sludge taking place in the soil frees the plant food material locked up in this sludge and renders it available, so that this type of sludge becomes an excellent fertilizer the second year after it has been dug into the soil. The experiences of a number of amateurs in Toronto who have been using ordinary septic sludge for several years in their vegetable and rose gardens, have seemingly quite established this fact.

The truest test of a fertilizer is not the amount of nitrogen, phosphate or other chemical present, but rather the availability of these chemicals as food for growing crops and the actual increase in the yield brought about by the fertilizer. Here again, fertilizers must be differentiated according to their ability to produce immediate results; whether they are available throughout the growing season; whether they leave a residue of humus and other materials in the soil; and whether or not they bring about exhaustion of the mineral elements of the soil.

Activated sludge, when aid-dried, is a dark brown, friable inoffensive material with a slightly earthy odor like that of decayed leaves. It consists largely of humus, but contains much more nitrogen, phosphoric acid and potash than does ordinary barn-yard manure. Furthermore, it is crowded with millions of the nitrifying type of organisms so essential to plant growth.

For the reasons given above as to the fertilizing value of manure, we have taken this for our standard of comparison and have not compared the fertilizing value of sludge with commercial fertilizers on a nitrogen, phosphoric acid or other basis. The real single, final test of any fertilizer or manure is the increase in the yield produced by it when compared with an equivalent amount of barn-yard manure.

We selected for our plot experiments, a site on very poor, humus-free clay soil, adjacent to our experimental plant. The surface was scraped to free it of any organic matter present, and four inches of water-washed sand was then thoroughly incorporated with the soil to a depth of ten inches. This was done to permit of aeration, to prevent the soil baking in the sun, and to make it friable. Six beds, each 10 ft. x 4 ft., were then laid out and separated from the paths by boards placed edgewise in the ground.

One bed was kept as a control, and no fertilizer added to it. The second was treated with 27 lbs. of air-dried horse manure, and the other four each with 27 lbs. of air-dried sludge (equivalent to 14½ tons to the acre). This is summarized below:—

Bed.	Air-dried fertilizer.	Quantity used.	Total nitrogen.	Total P_2O_5.
No. 1	—None (control)	0 lbs.	0%	0%
No. 2	—Manure	27 "	1.90%	1.00%
No. 3	—Activated sludge	27 "	2.50%	2.46%
No. 4	—Septic sludge from old bed, Morley Ave.	27 "	1.10%	.85%
No. 5	—Humus from brush filter, North Toronto.	27 "	1.30%	1.20%
No. 6	—Sludge from North Toronto tanks	27 "	1.21%	1.24%

On the 18th of May, 1917, the fertilizers were added and thoroughly incorporated with the soil, and on May 21st the seeds were planted in all the beds. Seeds were used except in the case of tomatoes and Spanish onions. A fairly thick planting was made so that plenty of seedlings would be available when thinning out, and a uniform number of strong seedlings of each variety could be left in each bed.

As each row of vegetables was pulled from the several beds at the same time, the complete plants, leaves and all, were placed in bags, labelled and brought to the labora-

*Journal of Industrial and Engineering Chemistry, Vol. 8, No. 1, Jan., 1916.

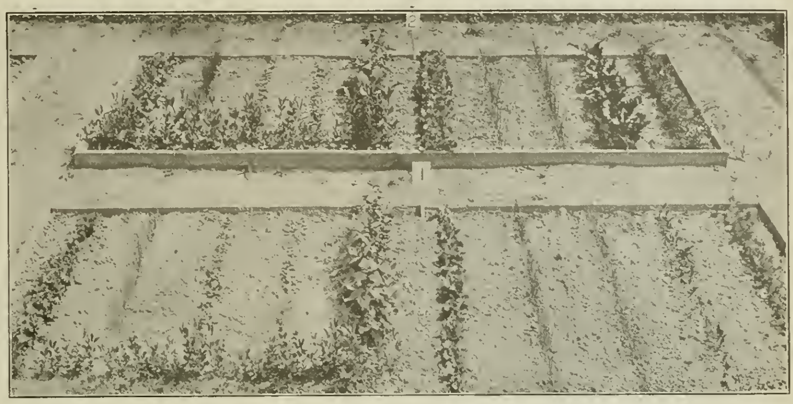
Toronto Health Department's Experimental Gardens

Planted to determine the fertilizer value of activated sludge.

These three photographs were taken on July 18th, 1917.

No. 2
Soil fertilized with 27 lbs. of horse manure

No. 1
Control Bed—same soil, but not fertilized

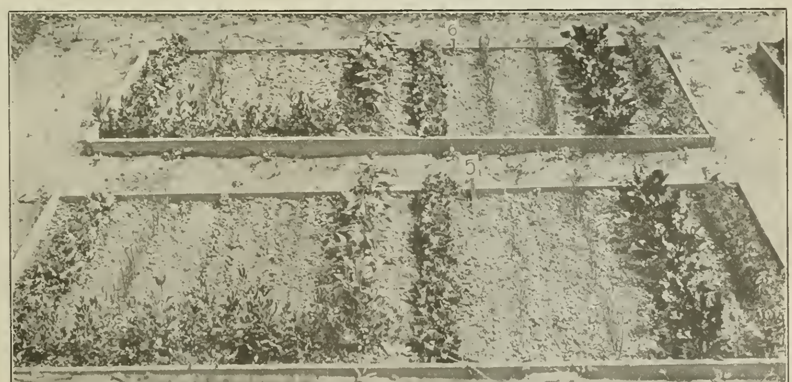


No. 4
Soil fertilized with 27 lbs. of septic sludge

No. 3
Soil fertilized with 27 lbs. of activated sludge

No. 6
Soil fertilized with 27 lbs. of North Toronto sludge

No. 5
Soil fertilized with 27 lbs. of North Toronto humus



tory. After the removal of adherent earth, the product of each bed was weighed; the tops, in the case of root crops, were then taken off and weighed separately, and the difference taken as the weight of the roots. Notes were also made as to the quality of the crop.

Before weighing, the crops were spread out on the floor in their respective groups and photographed. The photographs, however, only gave a general idea of the difference in size of the various groups because of the fact that the camera was tilted, in consequence of which the rows closer to the camera appear larger and the rows farther away smaller than they should be.

The plan adopted worked very well in practice and gave, we think, fair comparative results. Daily observations were made by the man who looked after the beds, and who was himself a gardener, as to appearance of the various vegetables, temperature, rainfall and cultivation. Every bed received exactly the same care and treatment.

We tried to eliminate every factor which might give any advantage to one bed over another, and to remove every influence that might have had any bearing on the growth of the plants except the actual effect of the fertilizers themselves during the course of one season.

The following are synopses of the results obtained:—

Table No. 1.—Early Radishes

	Control	Manure	Activated sludge	Morley Ave. sludge (septic)	North Toronto humus	North Toronto sludge
Weight, total—	92 grams	455	757	317	582	752
" roots—	59 "	350	490	200	417	518
" tops —	33 "	105	267	117	165	234
% Increase in roots over control —		493	730	239	606	778
Yield per acre—		5.04 tns	7 tns	...	...	...

Table No. 2.—Head Lettuce

	Control	Manure	Activated sludge	Morley Ave. sludge (septic)	North Toronto humus	North Toronto sludge
Weight, total—	31 grams	238	484	...	...	...
% Increase —		667	1,461	...	...	...
Yield per acre—		1.9 tns	3.88 tns	...	...	...

Table No. 3.—Lettuce (Grand Rapids)

	Control	Manure	Activated sludge	Morley Ave. sludge (septic)	North Toronto humus	North Toronto sludge
Weight, total—	75 grams	...	524	155	277	248
% Increase —		...	598	106	269	228
Yield per acre—		...	...	...	...	...

Table No. 4.—Beans

	Control	Manure	Activated sludge	Morley Ave. sludge (septic)	North Toronto humus	North Toronto sludge
Weight, total—	256 grams	296	525	357	377	531
% Increase —		15.6	105	39.4	47.2	107.4
Yield per acre—		1.78 tns	3.16 tns	...	...	...

Table No. 5.—Beets

	Control	Manure	Activated sludge	Morley Ave. sludge (septic)	North Toronto humus	North Toronto sludge
Weight, total—	79 grams	1,796	3,437	1,160	2,012	2,945
" roots—	24 "	730	1,737	437	891	1,169
% Increase —		2,941	7,137	1,304	3,612	4,770
Yield per acre—		5.85 tns	13.90 tns	...	...	...

Table No. 6.—Late Radishes

	Control	Manure	Activated sludge	Morley Ave. sludge (septic)	North Toronto humus	North Toronto sludge
Weight, total—	32 grams	75	315	472	285	738
" roots—	18 "	43	179	283	197	452
% Increase —		139	894	1,470	1,006	2,410
Yield per acre—		...	...	...	...	...

Table No. 7.—Tomatoes

	Control	Manure	Activated sludge	Morley Ave. sludge (septic)	North Toronto humus	North Toronto sludge
No. of tomatoes —	2	9	15	26	6	13
Weight, total—	29 grams	422	1,654	164	533	1,184
Aver. weight—	14½	47	110	82	89	91
% Increase —		1,355	5,603	466	1,738	3,983
Yield per acre—		5.07 tns	19.9 tns	...	...	...

Table No. 8.—Carrots

	Control	Manure	Activated sludge	Morley Ave. sludge (septic)	North Toronto humus	North Toronto sludge
Weight, total—	885 grams	1,680	1,535	1,425	1,560	2,695
% Increase —		96	80	66	82	215
Yield per acre—		20 tns	...	...	...	32.4 tns

Table No. 9.—Spanish Onions (16 Best)

	Control	Manure	Activated sludge	Morley Ave. sludge (septic)	North Toronto humus	North Toronto sludge
Weight, total—	41 grams	96	280	142	68	327
% Increase —		134	583	246	64	700
Yield per acre—		1.2 tns	3.4 tns	...	...	3.9 tns

Table No. 10.—Red Weatherfield Onions (8 Best)

	Control	Manure	Activated sludge	Morley Ave. sludge (septic)	North Toronto humus	North Toronto sludge
Weight, total—	67 grams	110	720	239	225	420
% Increase —		64	974	256	235	527
Yield per acre—		1.3 tns	8.7 tns	...	...	5.1 tns

Table No. 11.—Danvers Yellow Globe Onions (8 Best)

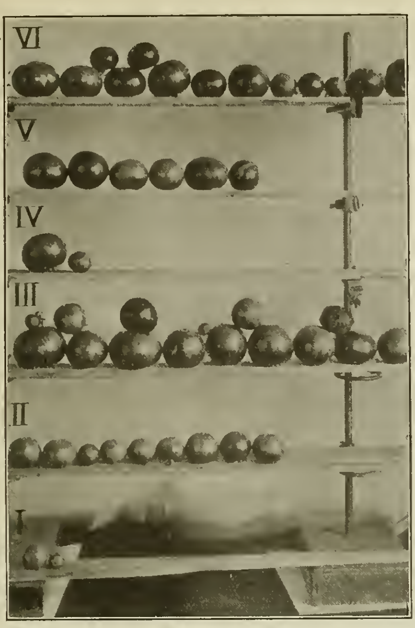
	Control	Manure	Activated sludge	Morley Ave. sludge (septic)	North Toronto humus	North Toronto sludge
Weight, total—	67 grams	124	232	260	184	169
% Increase —		85	246	288	174	152
Yield per acre—		1.5 tns	2.8 tns	...	...	...

Notes on Tables

Table No. 1.—The radishes were planted May 21st and pulled July 5th, approximately six weeks later. The same number of radishes had been left in each bed. The yield from the activated sludge and North Toronto sludge was about the same, but 40% greater than that from the manured bed.

Tables Nos. 2 and 3.—The two sets of lettuce, pulled July 19th, clearly showed the superiority of activated sludge as a fertilizer. These beds yielded double the weight of lettuce to that in the beds fertilized with ordinary manure and other sludges. Activated sludge, therefore, is a particularly good fertilizer for lettuce.

Table No. 4.—The beans, one of the legumes, were pulled August 7th, and did not show so wide a variation in the different beds as did the radishes and lettuce. Still,



No. 6
Grown with
North Toronto
sludge

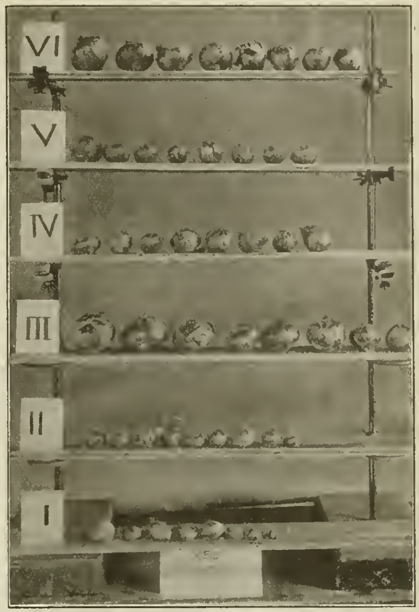
No. 5
Grown with
North Toronto
humus

No. 4
Grown with
septic sludge

No. 3
Grown with
activated
sludge

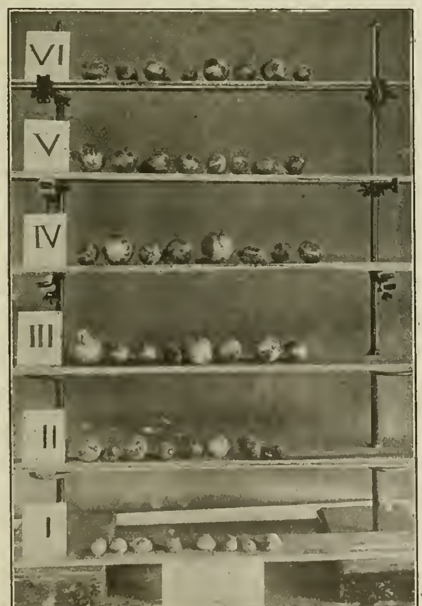
No. 2
Grown with
horse manure

No. 1
Grown without
any fertilizer



SOME EXPERIMENTAL VEGETABLE CROPS

Grown by the Toronto Board of Health to determine the fertilizer value of activated sludge



TOMATOES
shown in upper left-hand photo

RED WEATHER-FIELD ONIONS
shown in upper right-hand photo

DANVERS YELLOW-GLOBE ONIONS
shown in lower left-hand photo

SPANISH ONIONS
shown in lower right-hand photo

the crop from the beds fertilized with activated sludge and North Toronto sludge was 77% heavier than the bed fertilized with ordinary horse manure.

Table No. 5.—The beets were pulled on August 16th. During the period of growth the foliage on the beets in the activated sludge bed was much more luxuriant than that of the beets in any of the other plots. The yield of tops was double that from the beds fertilized with ordinary manure, and the yield of roots 138% greater. The sludge from North Toronto was considerably behind in this case.

Table No. 6.—The late radishes were not a success, though a large increase over the control was apparent in all cases; they were distorted in shape and in some cases rotted. The yield from the North Toronto sludge plot was greatest, but the sludge from the old beds, which had not been a successful fertilizer up to this time, made a good showing and indicated that aerobic action and nitrification of this sludge had taken place in the earth, rendering this fertilizer available as a plant food.

Table No. 7.—The tomatoes were picked October 2nd. During the growing season the tomato plant in the activated sludge bed had been most vigorous; the fruit had also ripened first on the beds treated with activated sludge and North Toronto sludge. The activated sludge bed gave the greatest number and the greatest total weight of tomatoes. The activated sludge gave a yield of 300% increase over the manure bed, showing that activated sludge is an ideal fertilizer for tomatoes. The yield from the plot fertilized with North Toronto sludge was considerably behind the activated sludge, though away ahead of the manure plot.

Table No. 8.—The carrots were pulled on October 9th. Except in the case of North Toronto sludge, which grew some huge carrots, the yield from the other beds were all much the same as that from the bed fertilized with ordinary manure.

Tables 9, 10 and 11.—The onions were pulled October 9th, and did not show phenomenal growth. Sludge from the beds gave a slightly better result than activated sludge in the case of Danvers Yellow Globe, showing that this sludge had latent fertilizing value. Activated sludge was the best forcer in the case of Red Weatherfield onions, giving an increase in yield of 554% over the manure crop. The yield of Spanish onions was practically the same in the case of the beds fertilized with North Toronto sludge and activated sludge, but much greater than that from the manured plots.

In casting about for the reason why the sludge from the North Toronto sedimentation tanks gave us almost as good results as activated sludge, we went back over the method in use in its preparation. The sludge is pumped from the settling tanks into beds. The water gradually flows away into the drains beneath, so that in from two to four weeks the sludge is dry enough to dig out. During this drying period it undergoes anaerobic action underneath the thick black crust which forms on the surface. Eventually, however, it dries sufficiently for aerobic action to take place in the spongy mass. The sludge is then dug out of the beds, carried away on small dump cars and deposited in long heaps where it lies exposed to the sun and air until finally removed.

In all probability a somewhat similar series of nitrifying actions which occur in activating sludge occur accidentally in this method of drying North Toronto sludge, rendering it suitable for immediate assimilation by plants. It would seem very probable that any sludge dry enough to be spaded would, if thrown into shallow heaps or spread out in layers on the ground, be converted by oxidation and bacterial action from a form not readily assimilable by plants to one readily assimilable by them. The same action would occur when dug into the earth itself, and presumably more rapidly in a porous soil than in a heavy clay soil. This latter point seems to be evident from results obtained from the anaerobic sludge dug from the old Morley Avenue sludge beds. This sludge made a very poor showing early in the year, but later on in the season appeared to be more readily available for the growth of plant life.

Conclusions

From the results tabulated above it is clearly evident that activated sludge is a most valuable fertilizer. When compared with the standard barn-yard manure used by the farmer, our results show the following:—

Increase in Yield Due to Activated Sludge Compared with Barn-yard Manure

Radishes	40.0%
Lettuce	103.3%
Beans	77.3%
Beets	138.0%
Late radishes	316.0%
Tomatoes	291.0%
Carrots	*—8.6%
Onions, Spanish	191.6%
Onions, Weatherfield	554.0%
Onions, Danvers Yellow Globe	87.1%

*The yield of carrots due to activated sludge was 8.6% less than the yield with the manure.

From the results obtained by us it seems to be true that crops such as lettuce, where the foliage itself is eaten, or crops like beans, beets or tomatoes, which demand a heavy growth of plant and leaf if the yield of roots or fruit is to be heavy, can be stimulated into very heavy growth by the use of activated sludge. The increase in the yield of onions due to this fertilizer is also great.

For the growth of lettuce or tomatoes under glass, activated sludge should, theoretically at least, prove to be a most valuable fertilizer. In the case of radishes, though the final weight was not materially greater, the radishes matured much quicker—which is just as valuable to the market gardener as if his crop were greater, for the quick growth is what is wanted. The same holds good of lettuce or beets, in which the growth is much more rapid than it was with the other fertilizers tested. These points are now being tested by experiments under glass.

It should be noted that the amount of air-dried manure added (14½ tons per acre), is about the maximum amount that could be used, and therefore in all probability the maximum crops capable of being produced by the addition of manure, had been produced.

If this is true, then the increase in yield due to activated sludge is very striking, and places at once a high monetary value on this material, for the value of fertilizers must be directly proportional to the crop returns yielded by them.

[Note—This article is printed simultaneously by *The Canadian Engineer* and by the Journal of Industrial and Engineering Chemistry, New York, by special arrangement with the latter journal and the authors.—Editor.]

According to the experience gained from the activated sludge plant at Milwaukee, where investigations on a thoroughly scientific basis have been in progress for a considerable period, the volume of sewage which can be treated by the activated sludge process is 10,000,000 gallons per acre under the most unfavorable climatic conditions, as compared with 3,000,000 gallons per acre as the maximum treatment by percolating filters under the most favorable conditions.

PRINCIPLES OF ROAD CONSTRUCTION

THE committee appointed some years ago by the American Society of Civil Engineers to investigate principles underlying road construction, and known as the "Committee on Materials for Road Construction and on Standards for Their Test and Use," has submitted its final report.

The report contains the general conclusions of the committee, discussion covering various kinds of pavements, surface treatments, etc.

The following is abstracted from that portion of the report covering the general conclusions:—

Selecting Material

One of the greatest problems for highway engineers is the proper selection of the particular material and form of construction that will most efficiently meet the conditions of any particular case. Selection of the kind of crust or pavement should be based on the following factors: First cost, maintenance cost, annual cost, ease of maintenance, durability, cleanliness, tractive resistance, slipperiness, favorableness to travel, sanitariness, noiselessness, and appearance. The special value of each of these may be estimated in each case under the local conditions of traffic, surroundings, climatic conditions, and physical and financial resources, as to both construction and maintenance, with proper regard for probable or possible changes in these circumstances.

Experience has demonstrated the value of a traffic census taken both preliminary and subsequent to the construction of a highway. It is one of the most important factors in deciding the selection of type of construction best suited to local conditions, considered from the standpoints of both economy and efficiency. Census counts on any highway should be supplemented by counts on cross and parallel highways. Such a census should not be the sole basis of selection, but should be considered as a guide in determining the value of the type to be adopted. Speed as well as weight of vehicles should be recorded.

Grade

Choice of material or methods of construction may be affected by the road grade. Conservative practice fixes the maximum limits for satisfactory results with grades as follows:—

Kind of roadway.	Maximum grade, %
Asphalt block	8.0
Bituminous surfaces	6.0
Bituminous concrete	8.0
Bituminous macadam	8.0
Brick cement filler	6.0
Brick bituminous filler	12.0
Brick "Hillside" block	15.0
Broken stone	12.0
Cement-concrete	8.0
Gravel	12.0
Sheet-asphalt	5.0
Stone block cement filler	9.0
Stone block bituminous filler	15.0
Wood block	4.0

The minimum grades allowable will depend on local conditions such as climate, type of construction, traffic, soil, etc. Except for roadways on fills, where the outside edges of the shoulders are at least 2 ft. above the level of the adjacent ground or where the roadway is laid over sand that never becomes water-logged, the grade of the road should never be less than 0.5 per cent. Under most favorable conditions, 0.25 per cent. has sometimes given satisfactory results, but should be used in exceptional cases only.

Width

In view of the continuous and rapid increase in number of vehicles and size of loads using the highways, economy requires designing highways with proper consideration of further increase. Where motor traffic comprises the largest part of that using the highway, the unit width of traffic lines should be taken as 9 or 10 ft.

The edges of bituminous pavements need protection, and sudden transition from the pavement to any soft shoulder material should be avoided by means of extra width, or by cement concrete or other edges, or such reinforcement of the shoulder material as may be necessary.

The width of roadways of rigid material should be at least equal to what would be prescribed under local conditions for a less rigid surfacing. For single-track roadways the width of pavement should be not less than 10 ft., and for two lines of traffic not less than 18 ft., unless exceptionally durable shoulders are provided. In a street or alley the width will originally be determined by the necessary location of the curb.

Too narrow a roadway causes a concentration of traffic that is apt to produce excessive wear of materials that would be suitable and efficient if the traffic were more generally distributed over it. Any tendency toward concentration of traffic in too narrow an area, as at sharp bends, should be avoided as far as possible by adjustment or separation of lines, adjustment of width, of crown or of slope of roadway.

Too great width results in unnecessary first cost and interest charges, and also maintenance and cleaning costs. In the case of pavements that require at least a minimum amount of travel to preserve the surface in good condition excess of width may result in disintegration of unused areas which may spread rapidly over the whole pavement.

Thickness

Determination of the thickness of a road crust or pavement should be based upon the character of the foundation and the weight of the traffic, with proper consideration of future increases in the latter. An absorbent subgrade material likely to become soaked with water may require a thicker slab than otherwise, or even the addition of an artificial foundation in order to disperse the stresses properly from pavement to sub-grade. In some cases unusual thickness may be desirable with the use of a minimum of cement, not only for reasons of economy, but also to avoid the effects of frost. A thickness for a concrete slab exceeding 8 inches should be determined upon only after thoroughly considering the possibility of all other means of meeting the conditions, such as improving the sub-grade.

Limits of Thickness for Pavement Layers

Kind of roadway.	Thickness of artificial foundation* (ordinary), in inches.	Thickness of sand cushion or binder course in inches.	Thickness of wearing course, in inches.
Asphalt block	5 to 8	....	2 to 3½
Bituminous surfaces	4 to 8	....	¼ to ½
Bituminous concrete	3 to 8	....	1½ to 3
Bituminous macadam	3 to 8	....	2 to 3
Brick	4 to 8	¾ to 1½	3 to 4
Broken stone	3 to 8	....	2 to 3
Cement-concrete, One course	......	....	5 to 8
Cement-concrete, Two course	4 to 8	....	2
Gravel	4 to 8	....	2 to 4
Sheet asphalt	5 to 8	1 to 1½	1½ to 2
Stone block	5 to 12	1 to 2	2½ to 5
Wood block	5 to 8	0 to ½	3½ to 4

*Not including extraordinary provisions such as V-drains or "sub-base" courses.

Variations in thickness of such surfacings as sheet-asphalt invariably result in non-uniformity of wear, and the same may be true of non-uniformity in thickness of other pavements as well.

Approved practice establishes the limits shown in the accompanying table for the extremes of thickness for the various layers of pavement or road crust.

Drainage

No matter what the kind of pavement or crust, under-drainage should be provided necessary to keep the sub-grade free from moisture. Also there should be provision for surface drainage. Storm-water reaching the roadway must be carried quickly and rapidly away from it to natural watercourses. Inlets, ditches, gutters, and culverts should be designed and placed so as to be least objectionable to users of the roadway and abutting owners, and to be must durable and least expensive under all conditions. A proper longitudinal grade for ditches and gutters is particularly important; also the cross-section of ditches, so that the sides may not slide in.

Under-drainage is, if anything, even more important where cement concrete pavement or foundation is to be used, because this cannot adapt itself to change in sub-grade due to frost without cracking, as other less rigid pavements can.

The crown necessary for removing surface water to gutters or ditches should be a minimum from the point of view of traffic and wear, but some crown is necessary, varying with the type of surface. Smooth pavements should be given a very flat crown; and where the longitudinal grade is sufficient to allow the water to run freely the crown should not exceed 3 inches in a roadway 30 feet wide. The recommended practice is from ¼ inch to ⅛ inch per foot for asphalt block, sheet asphalt, and wood block; from ½ inch to ¼ inch for bituminous surfaces, bituminous concrete, bituminous macadam, and stone block; from ⅜ inch to ⅛ inch for brick; from ⅜ inch to ¼ inch for cement concrete; from ¾ inch to ½ inch for broken stone, and from 1 inch to ½ inch for gravel. The slope for shoulders, where these are of natural earth, is generally 1 inch per foot.

Sub-Grade

Whatever the form of pavement, the sub-grade should be well drained, thoroughly compacted, homogeneous and stable, even when an artificial foundation is to be constructed. Uniformity in composition and compaction, as well as evenness of surface, is far more important than is generally recognized. It may even be desirable to increase the sustaining powers of the natural foundation by placing between it and the artificial foundation a layer of sand, gravel, broken stone, or similar material. A concrete foundation should not be relied upon for bridging soft spots, but these should be dug out and other material substituted and thoroughly compacted.

Artificial Foundations.

Where the character of the traffic justifies the use of an artificial surface, it also demands a correspondingly strong foundation. Whether or not an artificial foundation is necessary will depend upon local conditions; but in any event the greatest efficiency possible should be obtained from the natural foundation. Foundations of ample strength and permanence are especially necessary where the wearing surface is to be of cement concrete or block pavement, owing to their inherent lack of elasticity. Local conditions may occasionally justify omitting the artificial foundation for brick pavements where the natural foundation material can be made reasonably permanent, where brick is relatively low in price, and where only light traffic is expected.

The proportioning of materials for cement concrete pavements sould be made to conform to the needs and facilities of each case. Sometimes it is desirable to increase the mass at the expense of unit strength or for the sake of economy in cement.

Joints

For the ordinary joints in block pavements, the materials and methods of filling should be selected so as to produce not only a surface that will retain to the utmost its imperviousness and the stability of the blocks themselves in place, but they should also, so far as practicable, conduce towards evenness of wear of the surface of the pavement. If the blocks are resistant to abrasion, but are inclined to round off at the edges of the upper surface under traffic, such filling of the joints is desirable as will reduce such rounding off. On steep grades, where some roughness of the surface may be desirable to afford foothold for animals, some openness at the top of the joint is desirable and the softer joint filters may be preferred.

As it is desirable to secure waterproof pavements, sand alone should never be used as a joint filler. A bituminous filler may be preferred to a cement grout filler on account of the lower cost of street opening repairs, the better foothold provided for horses, and the securing of a more elastic and less noisy pavement.

For cement mortar joints a mixture of one cement to one sand is recommended. Uniformity in mixing and care and skill in application are essential to success. To insure uniformity, there should be a constant agitation of the mixture up to the moment of its application.

For bituminous joint fillers, care must be taken to select materials which will not be too brittle in cold weather nor so soft in hot weather as to flow out of the joints. It is believed, although not yet positively proved, that the use of a bituminous mastic would be an improvement over bituminous material alone. One of the greatest difficulties with bituminous fillers of any kind is that of properly filling the joints, and great care must be taken to insure this.

Expansion-Contraction Joints

Where expansion-contraction joints across a roadway at intervals are employed, the committee recommends the use of bituminous material and the abandonment of all forms of the so-called "armored" joints, because of the smaller interruption to the homogeneity of the road surface thus secured.

Cushion Courses

Where a cushion course is used, its thickness should never be greater than that necessary to compensate for the unevenness of the surface of the concrete base and that in the depth of the blocks used, plus about one-half inch to produce cushioning effect. The use of a cement-mortar cushion gives a monolithic structure with perhaps greater strength, but less capable of absorbing shock without injury than where a sand or bituminous cushion is used, especially where bituminous joint filler is used.

A certain amount of loam in sand used for cushion may be of advantage in giving the sand a greater ability to resist displacement, but it should not be so loamy or fine as to prevent proper spreading and compaction, or to afford too great capillarity.

Finishing the Surface

Pavements in which Portland cement is used for filling the joints or in the surface itself should be closed at least two weeks after completion.

As a result of numerous observations, the committee is convinced that, in a newly completed pavement the variations from a straight edge or templet 8 ft. long should not exceed ⅛ in. for asphalt block, bituminous concrete, brick, cement concrete, sheet asphalt, and wood-block pavements, and ¼ in. for broken stone roads, bituminous macadam and stone block.

Manhole Heads and Rails

In the case of macadam or bituminous pavements, the pavement should be laid about ⅛ in. higher than any manhole heads therein. The same should be done along street car tracks where these are rigidly set; although the committee does not believe that a bituminous pavement should ever be laid between rails, and advises laying stone blocks or brick for at least 18 ins. adjacent to the rails in the case of country highways, where the rails are not usually laid as rigid as in city streets.

STANDARD REVERSED CURVE FOR JOGS IN MAIN HIGHWAYS*

By C. M. Hathaway
Assistant Road Engineer, Illinois State Division of Highways, Springfield.

A STANDARD design for sharp reversed curves on main traffic ways has recently been adopted by the Illinois State Division of Highways. Except where limited by topographic conditions, the road system of the state follows the section lines. Because of earth curvature the range lines, bearing due north, were constantly convergent and required a correction to maintain the full six-mile length on the east and west township lines. Rather than make adjustment at each section corner, however, the corrections were made at certain definite intervals and errors in bearing and chaining were also made at the same place. Consequently, pronounced "jogs" in the range lines are apparent at these points. The east and west township lines were similarly corrected for errors in bearing and chaining, as shown by numerous offset.

That this fact alone constitutes the need of a design to overcome the resulting sharp turns at such points is seen by the fact that in a system of 100 miles of north and south road six or eight such jogs may be anticipated, while on an equal length of east and west road three or four may be encountered. Topography and the tendency to follow the "line of least resistance" may be further counted on to provide an additional number of unsightly and dangerous reversed curves. The necessity for a standard design was the result of the contemplated state-wide system of highways and the recent marked increase in the volume and speed of traffic. These same forces had produced designs for methods of lengthening out curves at 90° turns. In the case under consideration the layout is very simple and is designed to fit any offset length, as *A-B*, for example. The tangent distances governing the new tangent *C-D* and the tangents to the curves *EG* and *FH* are always equal to *A-B*. The angles Δ and Δ' are constant, and the radii of the curves *EG* and *FH* are thus readily determinable.

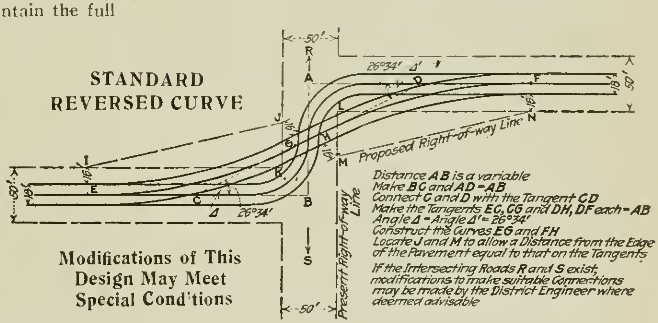
*From "Engineering News-Record" of New York.

The new right-of-way lines *IJ* and *MN* are so located that on the two curves *EG* and *FH* the same minimum distance to the inner edge of the pavement will be maintained as on the original tangents.

As a field inspection would be necessary to work out the details for any particular case, no attempt has been made to set limits within which this design may be used. Topography, value of land needed for right-of-way, and the necessity for connections with the intersecting roads, would constitute a limitation on maximum values of *A-B*, while with minimum values a tangent similar to *C-D* might easily be run in so that the angles Δ and Δ' would not exceed 10° and the curves *EG* and *FH* might then be omitted. From a general knowledge of the Illinois road system, however, the usual length of offset commonly encountered where the elimination of the reversed curve would be feasible might be safely estimated from 25 ft. to 150 or 200 ft.

Considering a typical case where *A-B* equals 100 ft., it will be found that the saving of pavement along the new line *E-F* is 80 sq. yds. Estimating concrete at $1.70 and brick at $2.20 per sq. yd., the saving on pavement would be $136 for concrete and $176 for brick. The new right-of-way required on both sides is only 0.16 acres. and allowing $300 per acre for land, the total cost for this item would not exceed $50. There results a net saving of $86 or $126 in construction cost, an easy riding curve pleasing to the eye is obtained, and primarily the dangerous hedge fence or corn row, always an obstruction to the vision of the driver, is no longer a menace to traffic and a limitation to reasonable speed.

Lengthening the line of clear sight on a turn is always the paramount issue and it will be noted that, for values of *A-B* from 0 to 25 ft., there could be no obstruction to line of clear sight since the centre line of each tangent is on a line with one right-of-way line of the other tangent. For higher values of *A-B* the clear sight is at least as long as the new line *E-F* and constantly increases with *A-B*. It should also be noted that in actual practice the area of right-of-way actually required could be lessened appreciably and still give ample ditch room on the inner sides of the two curves without materially affecting the line of clear sight.



STANDARD REVERSED CURVE

Modifications of This Design May Meet Special Conditions

Provision for suitable turns into the intersecting roads *R* and *S* would suggest modifications of this design not shown on the drawing. In Illinois the roads intersecting the average main highway are by a large majority small "feeders" leading back into agricultural territory. Such roads must remain unimproved for years, and should therefore receive no especial consideration in influencing the proposed alignment of the main road. When the in-

(Concluded on page 402)

CANADIAN SOCIETY OF CIVIL ENGINEERS ELECTIONS AND TRANSFERS

At a meeting of the council of the Canadian Society of Civil Engineers held in Montreal on Tuesday, April 23rd, the following elections and transfers were announced:—

Bell, Frederick John, of Toronto, Ont., elected a member. Mr. Bell was born at St. John, N.B., in 1873, and was educated at Manitoba University and St. John's College School, Winnipeg. For over fourteen years Mr. Bell was connected with the Canadian General Electric Co. Later he was for three years general manager and engineer of the British Canadian Power Co., Cobalt; six years general manager Canada Wire and Cable Co., and is at the present time president and general manager of the latter company and also of the Leaside Munitions Co.; vice-president of the St. Catharines Steel and Metal Co., and manager for E. A. Wallberg, C.E., Montreal.

Campbell, Walter Graeme, of Toronto, Ont., elected associate member. Mr. Campbell was born at Fullarton, Ont., in 1875 and was graduated from the School of Practical Science, University of Toronto, in 1902. He is at present connected with the firm of Campbell & Lattimore, contractors, Toronto.

Dick, William J., of Ottawa, Ont., transferred from associate member to member. Mr. Dick was born at Nanaimo, B.C., in 1883, and received his degree of B.Sc. at McGill University in 1908, and his degree of M.Sc. in 1911. Since 1910 he has been with the Commission of Conservation, Ottawa, as a mining engineer.

Erskine, John., of Hamilton, Ont., transferred from student member to associate member. Mr. Erskine was born at Glasgow, Scotland, in 1886 and received his degree of B.Sc. at Queen's University in 1912. For four years Mr. Erskine was engaged in designing and drafting for the Hamilton Bridge Co. and later was placed in charge of engineering work on the Bloor Street Viaduct, Toronto, for that firm. He is at present a captain in the infantry.

Gillis, Walter Cunard, of Ottawa, Ont., elected associate member. Mr. Gillis was born at Tide Head, Restigouche County, N.B., in 1881 and obtained his degrees of B.Sc., and M.Sc., at New Brunswick University 1907-1910. Since 1914 he has been assistant and chief draftsman to O. S. Finnie, Department of the Interior, Ottawa.

Guy, George Lorne, of Winnipeg, Man., elected a member. Mr. Guy was born at Portage du Fort, Quebec, in 1882, and is a graduate of Queen's University, class of 1902. Mr. Guy is at present engaged in private electrical practice and is also engineer of the Public Utilities Commission of Manitoba.

Haanel, Benjamin F. C., of Ottawa, Ont., elected a member. Mr. Haanel was born at Cobourg, Ont., in 1877, and obtained his degree of B.Sc., at Syracuse, N.Y., in 1899. He also took a two-year special engineering course at the Massachusetts Institute of Technology. For some time Mr. Haanel was engaged in engineering work for the American Bridge Company and United Engineering and Contracting Company, and is at present chief engineer, Division 7, Fuels and Fuel Testing, Mines Branch, Department of Mines, Ottawa.

Johnson, Charles, of Oakville, Ont., elected a member. Mr. Johnson was born at Mildmay, Ont., in 1881 and obtained his degrees of B.A.Sc., class of 1906, and C.E., class of 1917. From 1904 to 1914 he was with the Canadian Northern Railway; from 1914 to 1917, was assistant engineer, Toronto-Hamilton Highway Commission, Oakville, and is at present with the Toronto and York Radial Railway.

Meade, John Campbell, of Regina, Sask., elected associate member. Mr. Meade was born in Ireland in 1881 and was educated at Owens College, Manchester. Before the war he was in the city engineer's office, Regina, enlisting in 1914 in the Canadian Engineers.

Miles, Edmund Lancelot, of Calgary, Alta., transferred from associate member to member. Mr. Miles was born at Port Arthur, Ont., in 1883. For some years Mr. Miles was engaged in railway construction work. In 1909-10 he was resident engineer for Galt & Smith on the construction of the waterworks and sewerage systems at Wetaskiwin, Alta. From 1910 to 1913 he was a junior member of the firm of The John Galt Engineering Co., Calgary, and later was for two years vice-president and secretary of that firm. Since 1916 he has been with the Department of the Interior, Irrigation Branch, Calgary.

Prevost, Raoul de M., of Montreal, elected associate member. Mr. Prevost was born at St. Jerome, Que., in 1887 and was educated at L'Ecole Polytechnique Institute. Since 1912 Mr. Prevost has been with the Roads Department, and is now acting as first assistant engineer on the staff of the Goedetic Surveys Department, Montreal.

Rindal, Harold, of Vancouver, B.C., elected a member. Mr. Rindal was born at Tyvold, Norway, in 1879 and for some time was connected with the Norwegian Government Railways and Pennsylvania Railway. He is at present with the C.P.R. in charge of all engineering work in British Columbia District.

Smith, Frederick Granville, of Ottawa, Ont., elected associate member. Mr. Smith attended McGill University and also took a two-year course of lectures on structural engineering from W. Chase Thomson, Montreal. He is at present assistant structural engineer, Department of Public Works, Ottawa.

Townsend, Frank Willard, of Regina, Sask., elected associate member. Mr. Townsend was born at Wyoming, Ill., in 1885. From 1910 to 1913 he was resident engineer on the G.T.P. Railway, construction work, Regina boundary branch, and was later engaged for six months as engineer for Wells Bros. Co., Chicago, on reinforced concrete construction, Regina. From January, 1916, to date Mr. Townsend has been engaged as an engineer with the Imperial Oil Co.

Waddell, Needham Everett, of Kansas City, Missouri, transferred from associate member to member. Mr. Waddell was born at Tokyo, Japan, in 1884 and obtained his degree of C.E. at the Rensselaer Polytechnic Institute in 1908. Since 1915 Mr. Waddell has been a junior member of the firm of Waddell & Son, construction engineers, Kansas City and New York City, in charge of Kansas City office, specializing in bridge work.

Wotherspoon, William, of Calgary, Alta., elected associate member. Mr. Wotherspoon was born at Dolphinton, Lanarkshire, Scotland, in 1874. At present he is engaged as an engineer in the Department of the Interior, Irrigation Branch, Calgary.

Wentworth County Council have designated the Provincial County Road in that county for the highway between Owen Sound and Hamilton. It is expected that the provincial engineers will soon make a survey between Owen Sound and Hamilton, and that shoulders will be cut off, roads straightened and culverts and bridges built, so that all preparations will be completed for a permanent road as soon as conditions become normal.

Toronto Engineers Favor Partially Closed Profession

Members of the Toronto Branch of the Canadian Society of Civil Engineers Adopt Nine Resolutions Submitted by Committee on Prestige—Will Ask for Legislation Regulating Expenditure of Public Funds—Detailed Report of Important Meeting

THIRTY members of the Toronto Branch of the Canadian Society of Civil Engineers attended the meeting which was held last Thursday evening at the Engineers' Club, Toronto, to discuss the resolutions which had been offered by the Committee on Prestige. Professor Peter Gillespie, chairman of the branch, presided, and George Hogarth acted as secretary. The meeting was called to order at 8.30 p.m. After the minutes of the previous meeting and some routine correspondence had been read, A. H. Harkness, seconded by James Milne, moved the first resolution:—

"That the Ottawa Branch be invited to co-operate with the Toronto Branch in the drafting of a bill for the restriction of the employment of engineers upon public works, such as federal, provincial and municipal works, to those who have conformed to the requirements which shall be defined therein, and such draft, after being approved by the respective branches, to be submitted to the council of the Institute for consideration and action."

Wanted Prompt Action

F. B. Goedike moved an amendment that the draft bill be submitted to the individual branches, and when approved by them, that it be forwarded to council with a request that a ballot be mailed to all corporate members in ten days, to be returnable in thirty days, and if the ballot proves favorable, that immediate action should be taken thereon by the council.

Mr. Milne suggested that the word "prompt" before the word "consideration" in the last line of the resolution would have the same effect as this somewhat lengthy amendment.

R. O. Wynne-Roberts explained the difficulties of preparing an act of the sort called for by the resolution. He urged that no time limit be insisted upon and felt sure that the branches would have the support of the Institute.

May Ask for Dominion Legislation

J. G. G. Kerry said that they were dealing with a very complicated question. The joint committee of the Toronto and Ottawa Branches might find it necessary to draft more than one bill. There may have to be a bill for Dominion legislation and one for provincial legislation. The resolution does not limit the legislation to Ontario, and some of the Ottawa members may feel that a Dominion bill should be introduced. In any action that they may take, they must recognize other large bodies of engineers, particularly the Ontario Land Surveyors and the Mining Institute. If the bill were not very broad, strongly organized opposition might be expected from these bodies. Several years ago this was the case. The best way to avoid this is to discuss the problem with these organizations beforehand. These organizations must be favorable to the bill if it is to obtain any serious consideration by the legislature. The engineers had tried to obtain a similar bill some years previously without result, and they should go into this matter very carefully at the present time, and no time limit should be put upon the drafting of the bill or its consideration by the council.

A. F. Stewart said that it was not wise to limit the time or to urge speedy action. The engineers in other provinces are tending to get together along the same lines, and their co-operation would be desirable.

George Phelps thought that to insert the word "prompt" would be an unnecessary intimation that the council of the society is not always prompt in its actions.

Upon vote, the resolution was carried in its original form, with the addition of the word "prompt" before "consideration."

The Second Resolution

George McCarthy, seconded by E. M. Proctor, moved the second resolution:—

"That legislation be obtained forbidding the expenditure of public funds upon the construction of bridges, roads, docks, harbors, waterworks, sewerage and sewage works, electric light and power works and other undertakings, unless the plans for the same shall have been prepared by and the supervision is under the control of engineers who have conformed to the requirements defined in the proposed draft bill mentioned in resolution No. 1."

Prof. Gillespie enquired whether resolutions 1 and 2 were not the same. If the one were to be approved, would not the other be unnecessary?

Mr. Wynne-Roberts said that this was quite true, but that the committee had thought that the second resolution would better ventilate the subject, and it was also thought that there might arise certain contingencies not covered by the one resolution which would fall under the ban of the second. Moreover, he pointed out that the first resolution did not so specifically cover the question of supervision and construction.

Mr. Kerry said that the idea of the committee in presenting two resolutions was that the first resolution more specifically covers the direct employes of the government while the second resolution covers those who design, supervise and construct works which may be paid for wholly or in part by governments, and yet who are not direct employes of a government. For instance, consulting engineers would fall within this class.

Mr. Harkness, seconded by William Cross, moved an amendment that the words "public funds" be struck out and the word "monies" be substituted.

W. R. Worthington asked if this meant that a little bridge across a ravine would have to be designed by a registered engineer.

$500 Maximum Limit Suggested

Mr. Cross suggested putting a maximum limit of $500 on any such work which could be designed, built and supervised without the aid of an engineer.

Mr. Worthington said that this was going too far.

Mr. Hogarth asked whether this would not prevent a man from going into his own back-yard and building a structure for his own purposes.

Mr. Harkness explained that the amendment was intended simply to bring the proposed legislation into line with the legislation which is being introduced at the present time in some of the states in the United States. In other words, he said, it was to create a closed profession.

Mr. Worthington asked whether the members had considered the effect of such a resolution on the architects, mining engineers, etc. Is the council of the Institute to be representative of these bodies?

Mr. McCarthy, who is a member of the council, said that it is now partly so and is likely to be more so.

Mr. Wynne-Roberts advised going slowly. He said that if the expenditure of public funds can be controlled, let the matter of private funds stand for the time being.

When $2\frac{1}{2}$ Bags Equal a Barrel

E. L. Cousins said that he was glad to see the resolution call for engineering supervision as well as preparation of plans by engineers. He related an instance in connection with an Ontario township, where a certain engineer had been retained to draw plans for a culvert, 10 ft. span. The county would not permit the engineer to call for the tenders or to supervise the construction, but merely bought the plans from him, paying only $10 for them. Then the county council let the contract themselves and gave the supervision to a farmer at $1.50 a day. The contractor convinced the farmer that $2\frac{1}{2}$ bags of cement equalled a barrel, and as a result, after the culvert was built, the first heavy load that tried to go over it, went through it, and the engineer was blamed. Throughout western Ontario, said Mr. Cousins, municipalities everywhere call in engineers, show them the sites for bridges, drains, etc., and tell them to prepare plans and specifications. After an engineer prepares these, that is the last he ever hears of the work. They are turned over to the county council, and the county has control of the supervision of the work. Many well-designed schemes have been poorly constructed. The Ontario Land Surveyors are agitating at the present time against this practice. A surveyor is often called in to prepare plans for a drain costing, say, $50,000, and after he has prepared the plans and specifications, their interpretation is left entirely to men who have had little or no experience of any sort in engineering work. Mr. Cousins thought that there are so many evils to be corrected in the expenditure of public funds, that the engineers would be doing very well if they corrected these first, and then considered private funds later.

Mr. Harkness here explained that he was not sure whether he was in favor of his own amendment or not, and that he was contemplating its withdrawal. He was not sure whether it would be feasible to attempt too much. He had moved the amendment merely to draw out discussion.

"Who is an Engineer?"

Mr. Kerry advised against the inclusion of private work in the resolution. He said that the big question is, Who is an engineer? There are exceptionally competent construction men who can carry out certain engineering undertakings, but who could not qualify under any society tests. For instance, any legislation which the Institute might bring forward would be laughed out of court if it were to bar the Masters of Bridges and Buildings of the railroads from designing minor structures. It was well known that many of these men who are not graduate engineers, have marked ability up to a certain point. It is impossible to arrive at a sharp and clear definition of the word "engineer," said Mr. Kerry. He advised that the profession be closed only in regard to public work.

Mr. Worthington said that the closing of the profession to private work as well as public work would not prevent any Masters of Bridges and Buildings from carrying out their work, as they are all working under qualified engineers and the latter would be nominally responsible for the work, as they are now.

Mr. Kerry said that might be the case, but thought that the committee in drafting this resolution had in mind certain other cases of capable men who are not under engineers.

Mr. Worthington:—"For the public safety, why shouldn't they be under engineers?"

Prof. Gillespie suggested the inclusion of the word "railways" after the words "sewage works," and the word "public" before "undertakings."

Mr. Worthington suggested the word "engineering" before "undertakings."

Upon appeal from Mr. Cousins to let the joint committee of the branches deal with the details, and to pass the resolution without bothering about detailed wording, merely in order to give the joint committee assurance that the members are behind the spirit of the resolution, the members quickly concurred in this viewpoint and passed the resolution in its original form.

The Third Resolution

Mr. Wynne-Roberts, seconded by Mr. Cousins, moved the third resolution:—

"That it is desirable that the branch shall make provision for the payment of the branch secretary, and that it shall be deemed part of his duty to keep in close touch with the members and to render every assistance for their professional advancement."

Mr. Wynne-Roberts explained that the committee thought that the branch might desire to pay a man to keep in touch with the members, particularly to be of help to junior members. This would mean the expenditure of money, and the committee was not sure whether the branch would be able to afford this at present. The resolution had been put forward merely to obtain the ideas of the members.

Mr. Hogarth explained that he, as secretary, had nothing to do with this resolution. In connection with it, however, it might be interesting to the members to know the financial status of the branch. In the past the annual expenditure had been between $350 and $400 a year, whereas the branch has now $800 a year coming in as rebates from the parent society. This should, therefore, leave $300 or $400 which could be devoted to publicity or the payment of a secretary. The branch owns a $500 Victory Bond, fully paid-up, and has about $80 or $90 in a bank. Mr. Hogarth foresaw no contingency which would wipe out this credit balance.

Not Satisfied With Returns

Mr. Cousins asserted that the branch does not get enough from Montreal. He said that all the members of the branch are dissatisfied with the returns for the money they had spent in connection with the society. The money goes to Montreal and that is the last they hear of it. More of it should be rebated. If the members saw any real work being accomplished, they would be willing to contribute more liberally to the branch, but to-night it would be impossible to get a dollar out of them. He was satisfied that 90 per cent. of the men present thought they were getting no return from the money which they had invested in dues of the society. He suggested that a demonstrator from the University of Toronto be approached to act as secretary. With all due respect to the excellent work done by the present secretary, Mr. Hogarth, he thought that the branch should get a man who could devote his entire time to its work.

Mr. Proctor urged the appointment of a paid secretary. He said that anything which would give the members a little return for their money would be well worth while. A paid secretary would prod them up, and he

thought that what was wrong with this society was that the members were not prodded up enough.

Mr. Worthington said that if legislation is to be obtained, a paid secretary is certainly needed.

"A Dead Letter" Until Recently

Mr. Milne declared that, although he had been a member of the society for twenty years, it had always been a dead letter so far as he was concerned, and that he had not obtained the slightest benefit from it. It was only just recently, when he saw a better spirit in the local branch, that he had begun to attend the meetings. He did not think that the question of paying a secretary necessarily meant a change in personnel, and he considered that it would be highly advantageous for Mr. Hogarth to continue as secretary, provided that he would accept some small remuneration for the portion of his time which he devotes to the work. He moved an amendment to the effect that $300 a year be stipulated as the amount to be paid, and that it should be paid to the present secretary.

Mr. Kerry explained that the committee had the present secretary in mind when the resolution was drafted.

Thos. Taylor enquired whether the last clause of the resolution meant that the secretary would help the members to obtain employment. He said that a concerted stand had been taken recently among some engineers, with the idea of dealing with this matter of employment difficulties, and he wanted to know whether the members were to read into the last clause of this resolution any suggestion that the branch intends to deal with that problem.

Mr. Kerry said that the secretary should certainly act more or less as an employment agency. If members are looking for men, or if any members are out of a job, they should keep in touch with the secretary.

Prof. Gillespie said he thought that the Institute expected to deal with this question in a broader way, and to act at Montreal headquarters as a clearing house for positions.

Mr. Milne was not satisfied with this, and said that they were now dealing with the affairs of the branch, quite independently of Montreal.

Many New Members Expected

Mr. Hogarth said that the branch has now 331 members, of whom 110 are overseas, but on account of the broadening out of the society to include all of the electrical, mechanical, mining and chemical engineers, chemists, architects, etc., he expects a big increase in the membership of the branches, so that he did not think there would be any difficulty about funds.

Mr. Taylor said that the work involved was more than any one man could carry on successfully. His opinion was that there should be a secretarial committee for the purpose.

I. N. Stinson declared that the question of unemployment of engineers arose from over-production and from lack of salesmanship. Engineers need a good selling department, with national and local advertising. The employers should be lined up and told what the engineers can do. There are any number of a half dozen lines, said Mr. Stinson, in which he could undoubtedly earn more money than he is earning as an engineer. He thought that he would make a successful plumber; or, as he had handled camps, he felt sure that he could run a country hotel. In fact, said Mr. Stinson, there is not a member in the room, with the wide and thorough knowledge that they all have, who could not make more money if he were to engage in other work. The civil engineer is always looking for work. Work closes down and men are allowed to go for various causes. High-priced men are often allowed to go merely as a measure of "economy." Often these men cannot sell their services to advantage, although they know their work thoroughly. They have no selling ability. Therefore, a permanent secretary should be in the nature of a salesman who could sell their engineering services on their behaf.

The resolution was adopted in its original form, nobody having seconded Mr. Milne's amendment.

The Fourth Resolution

Mr. Kerry, seconded by Mr. Cousins, moved the fourth resolution:—

"That the council of the Institute be asked, in order to secure material for further discussion, to issue an enquiry to the members generally to ascertain the compensation received by engineers of various ages and in different classes, and employed in various technical services, and that steps be taken, if possible, to ascertain also the compensation paid to men of corresponding ages, classes and services in other professions."

Mr. Goedike urged the adoption of this resolution. He said that he knew of cases where resident engineers are getting only $24 a week, while street-cleaners get $22.

Mr. Harkness felt certain that a higher wage would soon follow the closing of the profession.

Mr. McCarthy urged that the council of the Institute be not loaded with useless work, and he asked that the resolution be defeated unless it would serve some specific and useful purpose. The American Society of Civil Engineers had secured much the same information some time ago, and what use had been made of it?

H. A. Goldman:—"None."

Mr. Kerry thought that the resolution should be carried. Much is heard about the payment of engineers, but we do not know the facts regarding their compensation. Are they paid fairly or not? This resolution is merely a recommendation to council to secure the facts. If the information called for by the resolution could be obtained and tabulated, any member could ascertain definitely the facts as to whether he is being fairly paid for the particular class of work in which he is engaged; he would have something to guide him. Speaking about salesmanship, said Mr. Kerry, few professions disqualify a man as a salesman more completely than does engineering. The engineer is engaged on technical problems, working alone over his drafting board, and has little opportunity to become acquainted with other men or with the general scale of payment, or with his own relative value compared with other men who are doing similar sorts of work.

Mr. Worthington said that hundreds of engineers are employed at such meagre salaries that it is a shame, and that if the information is at all available, it should certainly be obtained.

Always a Lower Bidder

Mr. Milne said that the main trouble is that some other man is always willing to take one's job at less money. "Supposing," said he, "that I am getting $3,000 a year and know my work thoroughly from A to Z and feel that I should get an increase, but at the same time another man, seemingly well qualified, goes to my chief and offers to do my work for $2,500, what am I to do about it?"

Mr. Proctor urged that the society had nothing to do with all this. He thought the proper function of the society is to collect and disseminate technical information.

If a man is worth more money he will get it. The society could not go to the city hall and tell the city council that it had to pay proper rates to its engineers. If the engineers can show that their work is worth while and that they are making money for their employers, they will be remunerated properly and accordingly.

Ability Needed, But So Is Opportunity

Mr. Taylor disagreed vigorously with Mr. Proctor's views. He said that he had come to the meeting for the special purpose of combatting such a statement should anyone make it. It is not always true that if a man has ability he will obtain recognition. First he must have opportunity. It is true that he must then have ability in order to hold the job. The society could do a great deal towards seeing that many men get their opportunity. Most engineers who have been successful have been "put in right" by their friends. "There are men here tonight," said Mr. Taylor, "who put me in right. I had technical knowledge, but if I had been required to depend upon that alone, I am sure I would never have gotten the opportunities. The society should by all means make efforts to give young men a chance."

Mr. Goldman thought that the city hall could be approached in the manner in which Mr. Proctor deemed impracticable. In Chicago, for instance, last year the engineers prepared a petition and also proved by documents that the engineers were then getting approximately the same salaries that had been paid thirty years ago for the same work, whereas all other class of municipal employees, from the city hall janitor to the mayor, had had their salaries increased upon several occasions. Thirty years ago physicians were glad to accept 50c. or $1 in payment of a professional call, but to-day they charge at least $2 or $3, yet engineers are working without any increase. The society should do something to bring about a general increase in the rate of pay of engineers.

H. E. Harcourt said that some years ago, when he was working in the city hall, he and some other engineers got together and decided that they would present an ultimatum to "the powers that be," that their salaries must be increased; but when they looked into the proposition, they found that there were about ten men awaiting for each of their jobs, and as none of them had enough money saved up to venture being out of work, the movement fell through. He thought that this substantiated Mr. Milne's idea that the trouble largely lay in some other engineer always being ready to take the job a little cheaper.

Mr. Proctor urged that the point of view of the employer be considered. He said that one cannot blame a man who runs an office and has heavy overhead expenses, if he can get a draftsman for $12 instead of $20. He said that before the war there were any number of migrating draftsmen who were willing to work for $8 a week, and they had "lots of testimonials, foolscaps of experience records, with their photographs attached, and all the rest of that sort of thing."

Mr. Stewart and Mr. Kerry favored obtaining the facts outlined in the resolution. Mr. Kerry said that the committee's draft of this resolution had been influenced by the replies that had been received to the questionaire which the branch sent out sometime ago. This questionaire had not been very widely answered, but the replies that were received—about fifty—were from a very responsible group of men. Only six replies had been received from men younger than thirty. Several replies had been received from men with ample experience; yet of those over thirty, 75% classed themselves as employees, and over 50% classed themselves as employes of the public in one way or another. The committee had, therefore, come to the conclusion that a considerable part of the membership of the society is in the employ of the public. "And this is extending," said Mr. Kerry, "because public utilities are extending. This being the case, it is well to find out and make public just what the position is regarding remuneration of engineers." He recognized the difficulty of obtaining information regarding remuneration, particularly from other professions, but he thought that this problem should be left to the council to solve and that an effort should be made.

The resolution was adopted.

The Fifth Resolution

Mr. Cousins, seconded by Mr. Cross, moved the fifth resolution:—

"That the council be asked to organize a scheme for the defence of members who have been attacked in the performance of their professional duties on what may appear unjustifiable grounds."

This was carried unanimously without discussion.

The Sixth Resolution

Mr. Kerry, seconded by Mr. Cousins, moved the sixth resolution:—

"That the technical work of the Institute can be most successfully carried on by means of technical sections to which shall be entrusted the organization of ordinary meetings, special sectional conventions, etc."

Mr. Kerry explained that the society as at present constituted is wide spread, covering many interests. The general meetings are not well attended, and the committee on prestige thought that if technical committees of the branch were to be organized, and special meetings put into the hands of these technical committees, a fuller attendance could be secured and the technical work of the society would be put upon a higher grade.

The resolution was adopted.

The Seventh Resolution

Mr. Cousins, seconded by Mr. Geodike, moved the seventh resolution:—

"That the executive committee be requested to consider the suggestion of holding weekly or fortnightly lunch meetings, at which addresses will be delivered and facilities given for the members to become better known to each other. Such practices as obtain at meetings of the Rotary or the Electrical Clubs might be followed."

Mr. Cousins claimed that many of the members of the Toronto Branch are not known to each other. He suggested adopting the plan of the Electrical Club, where each member stands up at the beginning of the meeting and tells his name, whom he works for and what line of work he is doing. Mr. Cousins thought that this had been one of the factors that had caused the Electrical Club to be such a live and well-banded association.

The resolution was carried unanimously.

The Eighth Resolution

Mr. Kerry, seconded by Mr. Cousins, moved the eighth resolution:—

"Whereas in the vocation of engineers, technical knowledge is necessarily of primary importance, that the council be asked to adopt every means in their power to make transactions of the Institute a complete record of Canadian engineering achievements and of Canadian engineering studies."

Mr. Kerry remarked that if this resolution be adopted, it would be in line with the functions which Mr. Proctor had in mind; that this resolution, if carried out, would ensure the society's aiding all its members in becoming technically well qualified. "Real advancement," said Mr.

Kerry, "can only come through thorough technical qualification." The resolution was adopted.

The Ninth Resolution

Mr. Kerry, seconded by Mr. Cousins, moved the ninth resolution:—

"That it is desirable to appoint sectional technical committees who shall undertake special studies and investigations to be assigned to them. The appointments to such committees to be made only after formal acceptance of office by the nominees, and the work of the technical committees to be carefully supervised by the executive committee. In the case of appointees failing to carry out the work, the executive shall, after due notice, request their retirement and elect others in their places."

Mr. Kerry said that the work of the society runs along two lines. The man who writes a paper for the society wants to deal with the extraordinary. As a result, the transactions largely deal with extraordinary work. The majority of engineering work is ordinary work, constantly repeated. Proper technical qualification requires members to know the best way to do ordinary work. Committees have been appointed in other societies to study the best way of accomplishing every detail of ordinary work, and something should be done along that line by the Canadian societies. It is thought that no work of this sort could be done more effectively than it is being done by the larger American societies, but certain conditions are different in Canada, and our work might be devoted to modifying or adapting the American work to suit Canadian conditions. Technical committees should be created to provide references for the members when ordinary work is being planned.

Mr. Cousins explained why no member should be appointed to any of these committees without his consent. He said that in the past members had been appointed to committees without being asked whether they would serve, and frequently without wanting to serve, and as a result the committees often accomplished nothing. He cited the excellent work done by the American Railway Engineering and Maintenance-of-Way Association, and asked why committees could not be appointed in Canada to standardize certain work in the same way in which that association has standardized work in which it is interested. "For instance," he inquired, "why could not a committee be appointed to standardize the best class of pavements, within certain broad latitudes, for use in the Province of Ontario?"

The motion was carried.

The Only Resolution Not Adopted

Mr. Cousins, seconded by Mr. Kerry, moved the tenth resolution:—

"As the Committee on Prestige and Influence has now completed the work referred to it, that it be discharged."

Mr. Hogarth said that the work of the committee had been well done. Members of the committee are all very much interested in this work and other branches are taking up the same questions. The committee is composed of some of the most prominent men in the branch, and it should be continued. The executive committee, said Mr. Hogarth, had often found the committee useful for the purpose of supplying information for inquiries from other branches, and also much data had been referred by the executive committee to the Committee on Prestige. He moved an amendment changing the first word in the resolution to "though," and the last word to "continued." This was seconded by Mr. Goedike.

Mr. Kerry objected, saying that he, for one, would have to resign from the committee on account of being out of town a great deal.

Mr. McCarthy urged that the committee be continued, if only for reference purposes.

Mr. Cousins thought that while all were willing to do their share of the work, the committee had been appointed for a specific purpose and it had served this purpose and it should be disbanded and a new committee appointed if another committee be needed. He said that some of the members, particularly the chairman of the committee, Mr. Wynne-Roberts, had spent a great deal of time on this work, and that in fairness to the committee they should be relieved of further work.

Mr. Hogarth's amendment to the resolution was carried, and the committee continued.

Mr. Worthington inquired, for information, who would appoint the joint committee which is to act with the Ottawa Branch in drafting the bills tending toward a closed profession.

Prof. Gillespie replied that it is the intention to leave this in the hands of the executive committees of the two branches.

Mr. Stewart moved a vote of thanks to the Committee on Prestige for its splendid work, and this motion was unanimously carried.

Will Organize Provincial Division

Mr. Goedike asked whether any progress had been made toward the appointment of a committee to point out to the Province of Ontario the desirability of plans for sewage disposal works, etc., being signed by qualified engineers. The chairman replied that this is a provincial matter which should be taken care of by the provincial division rather than the Toronto Branch, and as a provincial division is now being organized by the Toronto and Ottawa branches (the Kingston branch being dormant for the period of the war), the executive had decided to leave the matter stand until the provincial division had been organized.

In declaring the meeting adjourned at 10.30 p.m., Prof. Gillespie said that he did not recall any other meeting ever held by the Toronto Branch of the Canadian Society of Civil Engineers, where the discussion had been more general and intelligent. Many very important questions had been covered from wide viewpoints, eighteen members having taken part in the discussion, and he thought that the meeting, though not attended by so large a number as had been anticipated, had been one of the most productive ever held by the branch.

HALIFAX BRANCH, CAN. SOC. C.E.

Pursuant to authority granted by the council of the Canadian Society of Civil Engineers, a Halifax branch of that organization was formed on Friday evening, April 19th at a meeting held in the Nova Scotia Technical College. Pending the amalgamation of the Nova Scotia Society of Engineers with the newly formed branch, only a temporary organization was effected, as the membership of the branch will be considerably increased by the amalgamation. The officers temporarily appointed were F. A. Bowman, chairman; K. H. Smith, secretary-treasurer; L. H. Wheaton, W. P. Morrison, P. A. Freeman, J. Lorn Allan and R. McColl, members of the managing committee. Hiram Donkin, who is a member of the council of the society for the district including Nova Scotia, is an ex-officio member of the committee.

LEAKS FROM HIGH PRESSURE FIRE SERVICE MAINS*

By Henry B. Machen

FOR many years waterworks officials have discussed leakage from distribution systems and the effect of changes in pressure without being able to come to definite conclusions, due to the fact that, except that for single supply lines laid generally under most favorable conditions, after the main has been placed in service it has been impossible to separate leakage from consumption.

The high pressure fire system in the Borough of Manhattan, New York City, due to the fact that New York has not permitted any private connection to its fire mains, gives an opportunity to make tests on a distribution system of 128 miles of mains, 2,728 hydrants and over 4,748 valves covering an area of 3,675 acres. The system has received during its ten years' life most trying tests. Each year it has had the pressure raised from, say, 35 pounds to from 125 to 250 pounds, an average of over two thousand times a year, due to fire alarms within the district, and for each period of twelve hours in duration during which no fire alarm has sounded the pressure has been raised for one-half hour to 200 pounds for testing out. It is hard to believe that any other water system in the world has gone through similar service conditions.

Table 1 gives in considerable detail the castings used, separated by contracts, by size of main and further subdivided into full lengths of pipe of each size, offsets and bends of varying degree of curvature combined, 3-ways and 4-ways and short pieces. The short pieces were in many cases manufactured in the short lengths at the foundry; in other cases, they were cut from full lengths of pipe in the field. All castings used in the work except the pieces cut in the field were tested to 600 pounds at the foundry.

The 3-ways and the 4-ways were steel castings and considerable trouble was experienced at certain of the steel foundries in obtaining satisfactory castings. Two of the foundries, however, had practically no trouble in furnishing castings up to the specifications, the troubles of the others being due to lack of experience in this class of work.

Table 1—Pipe and Specials in the Manhattan High Pressure Fire System

Items	Totals all Contracts	Per Cent.
8-inch full lengths	437	3.2
8-inch bends and offsets	3,257	24.1
8-inch 3-ways, 4-ways	297	2.2
8-inch short pieces	9,533	70.5
Total	13,524	100.0
12-inch full lengths	26,729	64.8
12-inch bends and offsets	4,937	12.0
12-inch 3-ways, 4-ways	2,045	4.9
12-inch short pieces	7,563	18.3
Total	41,274	100.0
16-inch full lengths	9,561	64.8
16-inch bends and offsets	1,515	10.3
16-inch 3-ways, 4-ways	894	6.0
16-inch short pieces	2,783	18.9
Total	14,753	100.0
20-inch full lengths	3,894	62.3
20-inch bends and offsets	703	11.3
20-inch 3-ways, 4-ways	417	6.7
20-inch short pieces	1,233	19.7
Total	6,247	100.0
24-inch full lengths	3,513	65.1
24-inch bends and offsets	422	7.8
20-inch 3-ways, 4-ways	626	11.6
24-inch short pieces	838	15.5
Total	5,399	100.0
All sizes:		
Full lengths	44,134	54.4
Bends and offsets	10,834	13.3
3-ways, 4-ways	4,279	5.3
Short pieces	21,950	27.0
Total	81,197	100.0

*Journal of the American Water Works Association.

The mains were all laid in the lower portion of Manhattan Island, where subsurface conditions are most congested. This subsurface congestion shows readily in the figures given in the table by the large number of bends and short pieces of pipe used, even after the city had availed itself of its right to order moved gas mains and other interfering subsurface structures.

Table 2—Lengths of Pipe and Leakage in the Manhattan High Pressure Fire System

Items	Contracts 6-7 8-9	Contracts 19-20-21-22-23-27-28-29-30	Total all Contracts
24-in. pipe laid, lin. ft.	35,662.0	13,656.6	49,318.6
20-in. pipe laid, lin. ft.	29,849.8	26,330.0	56,179.8
16-in. pipe laid, lin. ft.	47,177.2	87,673.4	134,850.6
12-in. pipe laid, lin. ft.	154,466.1	224,429.0*	*378,895.1
8-in. pipe laid, lin. ft.	26,213.9	28,760.6	54,974.5
6-in. pipe laid, lin. ft.	860.0		860.0
Total pipe laid, lin. ft.	294,229.0	380,849.6	675,078.6
Linear feet of pipe joint	122,438	160,545	282,983
Allowable leakage for 24 hours	489,850	642,139	1,131,989
Actual leakage for 10 minutes	2,138.8		2,138.8
Actual leakage for 20 minutes		4,762.4	4,762.4
Actual leakage for 24 hours	307,741	343,391	651,132
Total number of tests.	647	720	1,367
Date put in service	July, 1908, to November, 1909	July, 1910, to December, 1914	July, 1908, to December, 1914

*Includes 150 feet of wrought iron pipe.

After the mains were laid they were subjected to an acceptance test of 450 pounds for a period of ten minutes for the earlier contracts and for twenty minutes for the later ones, the leakage being measured and for acceptance had to come within the limit of 4 gallons per linear foot of pipe joint per twenty-four hours. The results of these tests are shown in Table 2, which gives, separated into the same contracts, the linear feet of pipe laid of each size, the total linear feet of pipe joint, the allowable leakage, based on the specifications of 4 gallons per linear foot of joint per twenty-four hours, the actual leakage for the test period and reduced to the twenty-four-hour basis.

In testing, the test sections were in all cases between valves and doubtless a portion of the loss was due to water passing the valves limiting the section under test.

From the total column of Table 2 it will be seen that the mains were limited in the acceptance test of 450 pounds per square inch to a leakage at the rate of about 800 gallons per minute for the entire 128 miles. The actual gross leakage of all the tests was 452 gallons per minute. To-day there is a leakage, as shown on the Venturi meters, of 950 gallons per minute at an average pressure of 33 pounds, or nearly double the amount of leakage at 450 pounds pressure at the tests from ten to four years ago.

Investigations have been made to locate the leaks, but due to lack of force the work has not been systematically carried on. However, due to the wide range in pressures, property owners have themselves reported eight connections which had been placed evidently by mistake. There may be others not placed by mistake in which advantage is taken of the higher pressures available at times to fill tanks. The occasional erratic movement of the pen in the Venturi chart may be an indication of this.

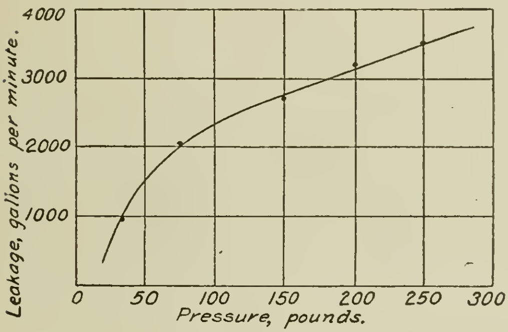


Fig. 1

The author had until recently a very firm belief that the leakage was past the main valve of the hydrants and was carried off to the sewer through the drain pipe connecting the drip and sewer. This belief has been shattered by an aquaphone test of each hydrant made by a most careful and competent inspector who covered every one of the 2,728 hydrants and found but 51 (1.9 per cent.) on which any sound could be detected, indicating leakage which could not be stopped by tightening the valves.

Of course, it might be said that a certain number of hydrants might be not tightly closed at all times in such a large number, but the system of maintenance is such that each hydrant is examined and repaired if necessary immediately after going out of service at a fire by an experienced machinist who reports to a follow-up system that the hydrant has been examined by him and left in good condition. The firemen, after an alarm, are the only users of the hydrants. Should any one else open a hydrant it is immediately known by an alarm bell operated by the Venturi meter recorder on the priming line.

During the past six years many miles of streets have been opened for the construction of the rapid transit subways, exposing over 54,000 linear feet of the high-pressure mains. No leakage has been found in the joints except an occasional sweat and from this evidence the Bureau of Water Supply is inclined to believe that the loss of water is not at the joints.

Fig. 1 gives the result of a test under varying pressure made on December 8th, 1916. Attention is called to the almost straight line of the upper portion of the curve, which seems to indicate that the leakage is not from fixed openings, from which a leakage varying as the square of the pressure should be expected.

It may be that the symmetrical results obtained and shown on the curve are but accidental; that as the pressure increased the main valves of the hydrants, which close under pressure, closed more tightly, reducing the leakage in the hydrant; that at the same time stuffing boxes in valves which are tight under low pressure might leak under the higher; that cracks in the pipe or steel casting not open under low pressure open under the higher.

Owing to a report of water coming in through the walls of a large sewer, there was located a split pipe which reduced the leakage under 35 pounds pressure by over 100 gallons a minute. This leak may have been of long duration, as at the time of starting excavations no indication existed at the street surface.

The writer presents the above facts for the purpose of discussion and not as showing any definite conclusion as to leakage.

CANADIAN SOCIETY OF CIVIL ENGINEERS

At the meeting of the council of the Canadian Society of Civil Engineers held last week in Montreal, a letter was read from F. A. Bowman, of Halifax, giving the information that at the annual meeting of the Nova Scotia Society of Engineers, held recently, the proposal of the council of the Canadian Society of Civil Engineers was accepted. The Nova Scotia society passed a resolution that they merge with a branch of the Canadian Society. A Halifax branch is therefore now being formed.

Branch at St. John, N.B.

The St. John, N.B., branch at present has a ballot outstanding, returnable at an early date, for the election of officers for the current year. This branch has been newly organized.

Alberta Division Meets

On April 27th an important meeting of the Alberta Division of the society was held to discuss general matters such as the status of the engineer.

Second General Professional Meeting

The second general professional meeting of the society will be held in Saskatoon in August. The first meeting of this sort was recently held in Toronto.

Report of First Professional Meeting

The council endorsed the decision of the executive committee to publish in May the first bulletin of the society "to be devoted mainly," writes Fraser S. Keith, the secretary of the society, "to the Toronto professional meeting."

Manitoba Branch

T. Duff Smith addressed the Manitoba Branch of the Canadian Society of Civil Engineers last Monday evening on "Coals: How Formed, How Found, How Produced." The regular branch meeting will be held this evening in the Engineering Building of the University of Manitoba. There will be an address on "Powdered Fuels," by George Pratt. On account of the importance of the fuel problem, members of other organizations have been invited to hear Mr. Pratt's address, and they were also invited to hear Mr. Smith's address.

Letters to the Editor

Efficient Earthwork Estimates

Sir,—Referring to an article in *The Canadian Engineer* of October 12th, 1911, by J. G. VanZandt, entitled "Efficient Earthwork Estimates," I enclose some tabular data, together with a formula for obtaining the figures to compile the diagrams there shown, and as it admits of being used with a slide rule should facilitate the calculation.

I have found these diagrams for the half section very useful as by means of them one can get the quantities in a three-level section close enough for estimating purposes.

Table I.

Side slopes.	Angle.	Tangent.	*d.*	*b.*	*M,*
1½–1	33° 41′	.66666	4.6666	14	16.33
1–1	45°	1.0000	10.000	20	50.00
¼–1	75° 58′	4.0000	36.000	18	162.00

Area on high side $= \dfrac{D+d}{2} \times w_1 - M$ (from Table I. M is a constant for any particular roadbed and side slopes),

but $w_1 = \dfrac{D+d}{t_h}$

where t_h (t on high side) is ratio in which sides of triangle ABC are running together = tan. of side slope — tan. of surface slope;

and t_l (t on low side) = tan. of side slope + tan. of surface slope.

Therefore,

$$\text{area on high side} = \frac{D+d}{2} \times \frac{D+d}{t_h} - M = \frac{(D+d)^2}{2\,t_h} - M;$$

$$\text{area on low side} = \frac{(D+d)^2}{2\,t_l} - M.$$

Table II., for the more usual side slopes, is easily compiled from a table of natural tangents for values of t_h and t_l, or it can be made out for direct contour intervals by substituting the angles corresponding to number of contour intervals per 100 ft.

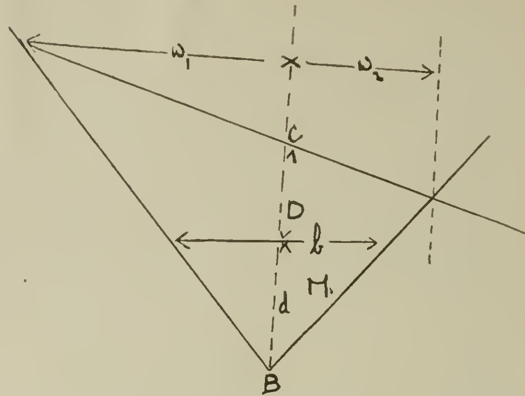
Table II.—For Values of $2\,t_h$ and $2\,t_l$

Surface slopes.	1½–1 $2t_h$	1½–1 $2t_l$	1 to 1 $2t_h$	1 to 1 $2t_l$	¼–1 $2t_h$	¼–1 $2t_l$
Level ...	1.33333	1.33333	2.00000	2.00000	8.0000	8.0000
Transverse—						
5°	1.15834	1.50830	1.82502	2.17498	....	....
10°	.98066	1.68598	1.64734	2.35266	7.64754	8.35266
15°	.79742	1.86922	1.46410	2.53590	....	....
20°	.60538	2.06126	1.27206	2.72794	7.27206	8.72794
22° 30′ .	.50490	2.16174	....	....	....	....
25°	.40070	2.26594	1.06738	2.93262	....	....
27° 30′ .	.29218	2.37446	....	....	....	....
30° ..	.17862	2.48802	.84530	3.15470	6.84530	9.15470
35° .	....	....	.59958	3.40042	....	....
40°		.....	.32180	3.67820	6.32180	9.67820
50°			....	....	5.61650	10.38350
60°			....	....	4.53590	11.46410
65°			....	....	3.71098	12.28902
70°			....	....	2.50504	13.49496
75°			....	....	.53590	15.46410

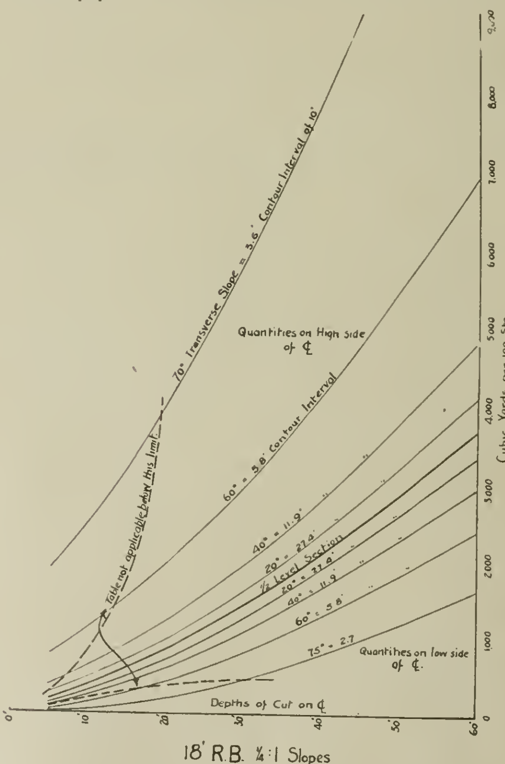
Table II. is computed as follows:—

tan. 33° 41′	.66666	.66666
tan. 5°	.08749	+ .08749
	.57917	.75415
	2	2
	1.15834	1.50830

The diagram which is the ultimate objective of the computation is shown in Fig. 2 and gives quantities for three level section by one addition. Fig. 2 is only



diagrammatic. The lines below which the tables are inapplicable are easily obtained from a sketch on cross-section paper.



18′ R.B. ¼:1 Slopes

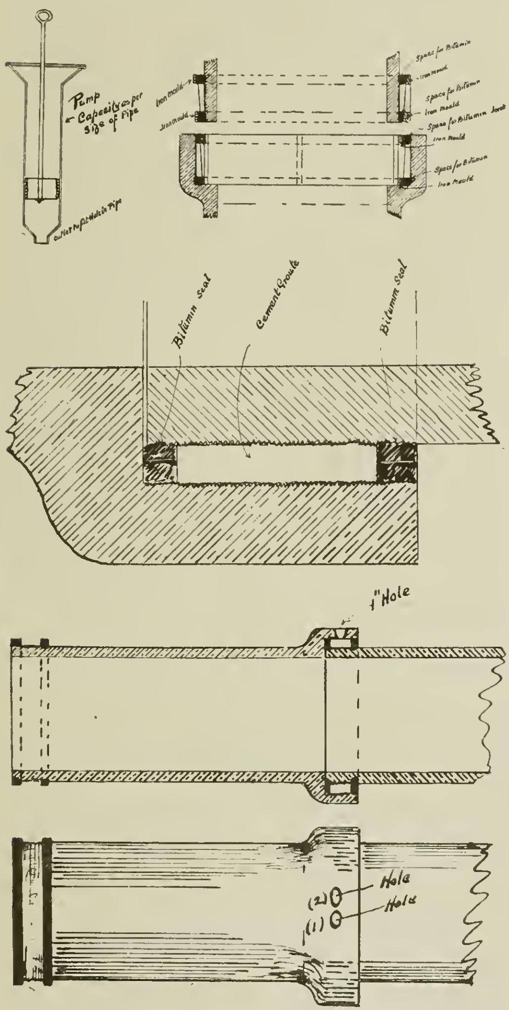
I have not seen the formula in just this shape in print before though doubtless it is not original.

F. PARDOE WILSON, M.Can.Soc.C.E.

Princeton, B.C., April 15th, 1918.

Sewer Pipe Joints

Sir,—I have read with great interest the article in your issue of March 7th on "Sewer Pipe Joints." I would like to add yet another method of securing a water-tight joint that has evidently not come under the notice of the engineers mentioned in the attached schedule of data, *viz.*, Hassel's patent joint.



Details of Hassel's Pipe Joint

I have had experience in the construction of many miles of vitrified pipe sewers in heavy water-logged ground, and I have never yet known this method to fail, when properly carried out. The following is the method of construction:—

Sewer pipes for use with Hassel's joints are cast with one inch deeper socket than the ordinary pipe. Two holes are cast in the socket about one inch in diameter, at the point marked on sketch. The outside spigot and inside of socket are scratched rough, before burning for a key to secure the material, which is applied to form a seal which consists of a mixture of sand, sulphur and tar well heated to boiling point in a small portable boiler until thoroughly blended. Small iron moulds, finished smooth to fit spigot, are used (see sketch) so that a thin layer of material is deposited which forms a seal, to prevent the cement grout that forms the joint from escaping. This work of moulding spigot and socket is preferably done on the site of works, as spigots being exposed are liable to be damaged by handling in transit, and hauling to the job. When pipes are placed in trenches and graded into position, it will be found that these make an accurate fit in straight line, provided the seal has been properly secured and lined to the body of the pipe. Cement grout is then poured into the space between seals (see sketch) and is forced round by means of a hand-pump in hole No. 1 until it pours out of hole No. 2 (see sketch). This will now be found to form a complete water-tight joint. In all cases where the work has been carried out by the writer, he has always found it advisable to secure a test of smoke, air or water, preferably water. Generally this test was carried out about forty-eight hours after the joints were poured, and about six to eight feet head was considered sufficient test for all ordinary purposes. The benefit of Hassel's patent joint in wet ground is that where subsoil pipes are used a free way can be given to subsoil water to pass to pumping plant. Care, however, should be taken to filter this water before allowing it to pass through the sewer, as there is a great danger of silting up the work under construction.

Stanford joints, mentioned in your article, were never very popular in England owing, I understand, to the amount of care required in handling, and also the waste of broken sockets by reason of the force required to push them home into position.

R. CUNNINGHAM, M.Can.Soc.C.E.

Edmonton, Alta., April 19th, 1918.

Name Accidentally Omitted

Sir,—In your issues of December 13th, 1917 and February 28th, 1918, appear articles descriptive of the plant of the Mattagami Pulp and Paper Co., at Smooth Rock Falls, Ont. I beg to add an item which does not appear in either of these articles, *viz.*, that Walter M. Scott, M.Can.Soc.C.E., of Winnipeg, was one of our consulting engineers in our municipal department, dealing with housing, water supply and sanitation.

S. R. ARMSTRONG,
Vice-President, Mattagami Pulp & Paper Co., Ltd.

Smooth Rock Falls, Ont., April 19th, 1918.

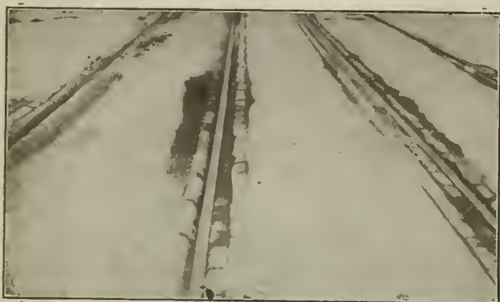
"Out of some two million miles of roads, or rights-of-way, in this country," said W. A. Alsdorf, secretary of the Ohio Good Roads Federation, in an address recently delivered before the Cleveland Engineering Society, "we have to-day, at the most optimistic estimate, some 200,000 miles which have received any attention or improvement of any character, and to the best of my knowledge, not over 40,000 miles of roads have been actually constructed with some degree of permanency and maintained in such a fashion that they could be used as an auxiliary transportation system. And, even this available road mileage is limited in its usefulness by the fact that it has been constructed under no central directing intelligence, that it is the result of local endeavors at widely separated points, and does not in any degree link up to form what can be referred to as a 'Road System'—roads which lead from some place to some place."

MAINTENANCE OF ASPHALT PAVEMENTS IN OTTAWA

By L. McLaren Hunter, A.M.Inst.M.&C.E.
City Engineer's Office, Ottawa.

MAINTENANCE of asphalt pavements is a problem which should receive more consideration, as upon maintenance largely depends the life of the pavement.

In Ottawa, very few repairs to asphalt pavements have been necessitated by the failure of the concrete foundation. The only cases were two streets where railways operated, and the reason was that the foundations were built to carry ten-ton cars and were used to carry the modern



Deterioration of Asphalt in Track Allowance Owing to Track Construction Being Too Light for Type of Cars Used

twenty-five-ton cars. These pavements were relaid two years ago.

The foundation for any pavement must be rigid, of course, and of sufficient strength to carry the traffic passing over it. Asphalt, being plastic, will follow a weak concrete in its sinking over sewer and water service excavations if the backfill has been insufficiently tamped. In Ottawa, reinforcing is resorted to in the case of "green" excavations, so that should they sink, the concrete would have enough stability to bridge the depression.

The basic requirements for a good foundation are the sufficient rolling and compacting of the subgrade, a good mixture and thickness of concrete, and allowing sufficient time for the concrete to set before laying the binder course.

In the photo is shown deterioration due primarily to insufficient thickness of foundation, and secondarily to the fact that the rails were only five inches in depth and very light, causing excessive vibration, which cracked the asphalt. The rails in places were depressed, allowing surface water to collect and seep in under the asphalt. Rotting action commenced and rapid deterioration immediately followed. Ultimately the street had to be repaved.

The accompanying diagram shows the present method of paving track allowance in Ottawa. Creosoted wood blocks or sandstone blocks are used to take up the vibration from street car traffic.

In repairing the streets last summer, we found several bumps or waves, due in most cases to defective binder. Other causes of waves are the use of too soft an asphaltic cement or too great a thickness of asphalt owing to a mistake in the grade of the concrete. These waves are very seldom seen in street intersections, owing to the cross-action of the traffic.

The deterioration of asphalt caused by the action of water may take place either from the surface downward or from the base upwards. To secure immunity from the first, merely a sufficient crown is necessary, with a good gradient for the flow of water along the gutters to the gullies. Mud, usually drawn onto the intersections of paved streets from unpaved ones, should not be allowed to lie long enough to cause deterioration.

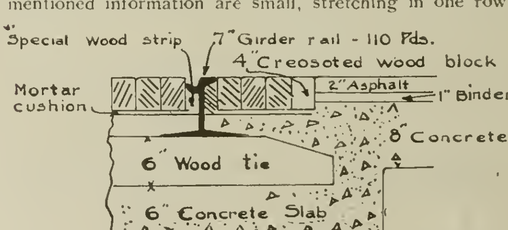
The upward action of water is more difficult to guard against, as the rotting action is seldom noticed until the asphalt collapses under the weight of passing vehicles. If the sub-soil drainage be good, and the gutter grades sufficient to take the water away quickly, this form of deterioration is not likely to occur. Illuminating gas produces results similar to the upward action of water.

Every endeavor is made to have repairs carried out within reasonable time after the disappearance of snow and ice in the spring. We go over our streets twice a year, first in early spring and then late in the fall. We are at present working out details for a patrol system for small repairs, the idea being to do away with the fall repairing and the reopening of the stationary asphalt plant. This patrol will have a repair wagon which will reheat asphalt previously prepared at the main plant, and will be able to repair about 100 sq. yds. of pavement per day. This should be enough to keep the streets in excellent condition.

A maintenance card is used to keep a continuous record of repairs from the time each pavement is laid. These cards are filed alphabetically, so that the extent and cost of repairs can be ascertained quickly whenever required. Spaces are provided on each of these cards for the following construction information:—

Name of street, date of beginning of the record, date of end of the record, kind of pavement, date paved, number of square yards, price per square yard, name of contractor, number of years guaranteed, depth of wearing surface, depth of binder, kind of foundation, depth of sand cushion, kind of grout, kind of brick, miscellaneous information.

These cards are $14\frac{1}{2}$ inches wide by $9\frac{3}{8}$ inches deep, printed on one side only. The spaces for the above-mentioned information are small, stretching in one row



Present Method of Track Construction in Ottawa

across the card near the top. The greater part of the area of the card is devoted to its main purpose, *viz.*, a record of maintenance, and is divided into seven columns, the headings of which are as follows:—

Year; Number of Yards Repaired; Total Cost of Repairs; Price per Sq. Yd.; Contractor; Cost per Yard Over Total Area; Remarks.

More attention is now being paid to maintenance in Ottawa, as, despite the fact that the mileage of streets maintained by the city has increased by about eight miles during the past two years, it has been found that the yardage of repairs has decreased. We attribute this to the methods of maintenance and to the rapidity with which small depressions that collect water are repaired.

PAY FOR ROADS BY LEVYING WHEEL TAX

By Charles A. Mullen
Director of Paving Dept., Milton Hersey Co., Ltd., Montreal

AN article, appearing in a recent trade publication, by George C. Warren, opens again the controversial subject of how we shall pay for our pavements. One possibility not dealt with by Mr. Warren, is charging them to the public through a wheel tax levied by the city, county or state. The writer would like to see this idea fully exploited; or to learn where it is in vogue and how it is working.

Why do we build roads and pave them? For wheels,—no other reason. Were it not for vehicular traffic—other than bicycles and baby carriages—sidewalks and footpaths alone would serve our purpose. And since we build the pavements for wheels, wouldn't it be logical to pay for them through wheels?

It has always seemed to the writer that a tax should be collected through a logical channel. At present, we are fooling ourselves very badly as to the cost of highway transportation. A railway must maintain its roadbed and collect the cost thereof in its freight charges and passenger fares, while an autobus line, delivery wagon or auto truck, or even a passenger automobile does not pay for its roadbed, and the expense thereof is not figured into its cost of operation.

It is true that some states in the United States are taxing automobiles and using the proceeds for road maintenance. This is a step in the right direction; but why not carry the principle to its logical conclusion by securing all the money for road building and maintenance through a wheel or vehicle tax? If roads are for vehicles and vehicles alone, why should the general city tax, or the abutting property, pay for them, instead of the owners of the vehicles to whom the wheel tax would be charged? They, in turn, would charge it into the cost of their services to the community, so that finally it would rest, as always, upon the ultimate consumer, but through the logical and proper channel instead of in the present unsatisfactory way.

Illogical procedure may usually be depended upon to produce illogical results. In the city of Montreal, which pays for both its pavement construction and pavement maintenance out of the general city fund, the illogical results have fully materialized. On the whole, Montreal probably has the worst paved streets in North America.

Because of a stringency in municipal finance, charged by some to war conditions, but due much more directly to purely local causes quite painful for a citizen of Montreal to mention, the "city fathers" thought it wise to neglect the street pavements. Thereby they avoided spending some money from the general city fund for those particular years when these particular city fathers were appealing to the citizens for their suffrage.

Money was saved to the particular general city fund; but in doing so they wasted a lot of money for the community. After a few years of this kind of "saving," the streets of Montreal are so bad that they can be traversed neither with pleasure nor in safety. Trucking firms were, even last year, threatening to sue the city for damages because of the excess wear and tear on equipment and the greater expense of smaller loads made necessary through the ill repair of the pavements.

Now, what the general city fund saved in dollars and cents was paid out, many times over, in equally good dollars and cents by the vehicle owners using the streets of the city. They paid heavily in repairs to wagons and automobiles, and in excess horse power required to move a given tonnage between given points.

Were the city of Montreal paying for its pavement construction and maintenance by a wheel or vehicle tax, this condition would not exist very long. The vehicle owners would not be slow to realize that they could get the same results at less cost by paying their money into a proper tax fund to build and maintain pavements, rather than by paying it to wagonsmiths, garages, horse-dealers and excess labor.

Some may object to the wheel tax as a means of paying for road service on the ground that it too closely resembles the old toll-roads system. To such, it can be said that there were two great objections to the collection of tolls: First, too much of the amount of the tax was spent in the collecting thereof; and second, the toll roads were privately instead of publicly owned. Of these objections, to the writer, the last only seems fundamental; the first is a matter of practical application that is overcome by the wheel tax.

Another objection that might be raised is that we are getting away from free public roads. But nothing is free. We are paying for them now, only by a different and less satisfactory method. Nothing that is the result of labor can ever be free. Natural resources may be, but not manufactured products such as roads. Someone must always pay; so why not have the burden fall equitably upon the road users through a wheel or vehicle tax?

The writer is not ignoring the fact that so radical a change in the method of paying for our pavements would meet with a lot of opposition. Neither does he claim to have suggested anything new, for the plan was advanced by others long ago. What he does suggest is that we really begin to think about doing something along these lines. It's a long way to Tipperary, but it is probably an even longer journey to a satisfactory method of taxation to pay for road building and paving. Let's hear what the single taxers and others have to say about it!

WAR'S EFFECT ON WATERWORKS

THE following resolution regarding the effect of war upon the maintenance and management of waterworks, was adopted by the executive committee of the American Water Works Association at a meeting held on April 8th, 1918:—

Whereas war-time conditions unavoidably have developed cardinal difficulties in the efficient operation and maintenance of waterworks properties, both municipally and privately owned, and in some cases the situation and relief of this important public utility has become a subject of grave importance; and

Whereas the very existence of a modern and civilized community depends upon a pure and adequate supply of water; and

Whereas the water rates now existing were, as a rule, fixed before the war and were based upon conditions which then prevailed; and

Whereas reliable information from a representative group of waterworks shows that the average increase in operating expenses in the past three or four years has amounted to some 40 per cent., and that during the same period the gross revenue of this group of waterworks has increased but about 7½ per cent.; and

Whereas the increased cost of operation, the difficulty of providing for maturing obligations, and of making necessary extensions to meet the requirements of the nation's war needs and of expanding industries which water departments and companies share with all other

public utilities, are, in the case of waterworks, intensified by certain conditions peculiar to this service as

(*a*) A waterworks can gain no relief by temporary cessation of service at stated times or in certain areas; there may be moonlight schedules, heatless days and areas, less frequent train service, etc., but water service, from its very nature, must be continuous, both in time and extent. The needs of large industries or war needs cannot be met by diverting from other consumers. A waterworks must carry its normal load and at the same time take care of its emergency service.

(*b*) The nation's war program, including the mobilization of the country's industries, indispensably requires extensions of service by waterworks. A waterworks extends its service and enlarges its facilities by increasing its pumping and purification equipment and by laying additional pipe. In such extensions iron products constitute the chief element, which products have increased in price enormously and probably more than any other commodity in general use. Since 1915, iron pipe has increased in cost 150 per cent., and pumping machinery and filtration equipment from 100 per cent. to 200 per cent.

Since there can be no enlargement and extension of industries to meet war needs without increased and extended water service, waterworks are powerless to avoid expenditures for this purpose and unable to escape the payment of such vastly increased prices.

(*c*) The greatly increased cost of operation, which affects all public utilities, seriously affects water departments and companies, in particular, for the reason that the largest single item of expense in the operation of waterworks is fuel. In normal times fuel constituted about 15 per cent. of the total cost of operation. Now fuel cost is approximately 30 per cent. of the total cost of operation. In addition to this, the cost of water purification has increased more than 40 per cent. and cost of distribution more than 20 per cent. of the normal cost of operation, and

Whereas the general public, and in fact many State and municipal officials, appear not to visualize clearly that even properly imposed increases in the cost of labor and essential materials must of necessity likewise increase the difficulties and cost of managing waterworks properties efficiently; and

Whereas considerations of equity and the vital necessity of maintaining continuous and adequate service require that the water consumer bear his proportionate share of such necessary increase in expense that water departments, whether municipally or corporately operated, should not be forced to operate at a loss or be deprived of the reasonable return on their business, necessary to command capital, upon advantageous terms, for required extension and betterment of the service; and

Whereas in time of war it is vitally essential that so far as is consistently possible it is necessary to conserve the health and well being of the public, and to guard against fire losses, by providing pure and adequate water service to the public, and to the industries, particularly those engaged in the manufacture of war materials; and

Whereas without an equitable balance between the cost of operation and management of waterworks and the revenue received from service it is inevitable that the maintenance in a satisfactory manner of this vitally important essential must of necessity deteriorate; therefore

Be it and it hereby is Resolved that for the benefit of the members of the American Water Works Association, and through them for the enlightenment of the public at large, the foregoing facts and information be immediately printed in pamphlet form by the association.

DRILLING FROZEN GROUND WITH HOT WATER*

By Henry Mace Payne

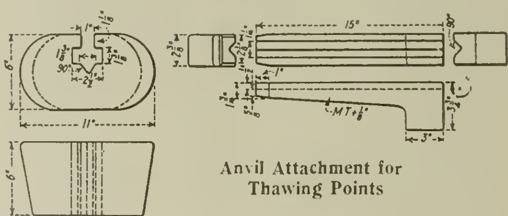
An average of 46 per cent. of the frozen material in place is ice. When this is melted, the boulders are loosened, so that a thawing process started at bedrock creates a subterranean cavern, which, as the thawing continues, causes a gradual caving to the surface and a shrinkage in volume of the entire mass.

To drive the thawing points to bedrock a hollow-steel rock-drill cross-type bit was welded to the end of a ¾-in. steam point and a 3/32-in. hole was drilled at the top of each of the four flutes to the bit. Thus, instead of one 3/16-in. hole at the end, as in the old point, there are five holes, four in the sides and one in the end, and as a result it is possible to drive the point directly through a boulder.

A frozen boulder when partly drilled through expands from contact with the hot water and splits, allowing the point to drop below to the next boulder. Meanwhile the hot water has a sluicing effect from the four side holes, not obtainable with the one orifice only, and thawing proceeds with consequent greater rapidity.

A further advantage of hot-water thawing is the elimination of the possibility of back pressure or suction through the thawing point, with consequent choking by mud, etc., due to steam condensation in the lines, or pressure drop in the boiler.

To facilitate driving of the thawing points and to eliminate the use of ladders and chances for breaking points, anvils weighing about 100 lbs. may be forged from old dredge-bucket pins, slotted so as to pass over the thawing point, and held in place by a key. (See accompanying illustration.)



Anvil Attachment for Thawing Points

Handles may be inserted on each side of the anvil and the helper can turn the point as in regular rock drilling, while the operator standing on the ground alongside strikes with a sledge hammer, driving the point until the anvil reaches the ground. The key can then be knocked out, the anvil raised to a convenient height, and the driving operation resumed.

In thawing, the points are regularly spaced in triangular relation to each other 16 ft. apart between any two adjacent points. This establishes a fixed distance from the points to the supply line. Rubber hose is used only during driving, after which a standard pipe connection is put on. Between the pipe connections and the main line ordinary railroad train hose couplings may be inserted, obviating leaky unions and facilitating connecting and disconnecting operations. Two pairs of point men, each equipped with an anvil, can drive five drill-bit points in 10 hours, *viz.*: Driving, 6 hours; pulling, 1½; connecting, 1½, and miscellaneous, 1 hour.

*Abstracted from a paper read before the Canadian Mining Institute.

REPORT ON THE PROBLEMS OF SMALL TOWN SEWAGE WORKS

PROF. J. H. DUNLAP recently spent three months investigating the sewage works of the State of Iowa for the Iowa Board of Health. In an address to the Iowa Engineering Society, he quoted direct testimony from 39 of 100 plants, showing that the operation of the average small-town sewage disposal plant is shamefully neglected. His address was reprinted in "Engineering News-Record," of New York, from which the following is abstracted:—

Typical findings at some of the plants which have sedimentation tanks and sand filters are given, the figures in parentheses being population, 1915 census.

Ackley (1,289): The filters were weedy, the sand ridges between the two beds were broken through, and there were holes in the filters leading directly to the underdrains. Care insufficient.

Albia (5,138): The two Imhoff tanks were miniature septic tanks. The slot connecting the sedimentation chamber with the sludge chamber had been clogged and the sedimentation chamber was well sludged up. The flat slab covers made it practically impossible to operate the tanks properly. The filter beds were somewhat out of level, and the distribution was uneven. Care insufficient.

Carroll (4,031): The plant consists of two septic tanks and five sand filters. The latter have about reached their normal capacity. The plant was in excellent condition with the exception of some trouble with siphons. It receives regular, intelligent care.

Grinnell (5,061): The two Imhoff tanks were found to be sludged up. The four sedimentation chambers were miniature septic tanks. The distribution upon the sand filters was imperfect. Trouble was experienced in removing sludge from the tanks, since no water connections were available. The plant was receiving regular but not intelligent care. The slab covers have now been removed.

Lake View (814): The two filters were somewhat weedy. Soil from the tanks was being washed down upon the surface of the beds. The outfall wall was being undermined. Care received every two weeks.

The impression still remains in the minds of many city officials that septic tanks are cure-alls. In one case these tanks, built in 1913, had been bypassed ever since their construction.

As with the grit chamber, the old-fashioned slab cover close to sewage surfaces with a few manhole openings must be abandoned. The inlet channels to the septic tanks should be so designed that they are self-cleansing. Since most of the Iowa plants suffer from excessive infiltration of ground water during a long period in the spring, ample overflows must be provided, so that the septic tank may never work at an excessive rate. Other points demanded are ample sludge beds, hopper instead of flat-bottomed tanks, conveniently arranged valves of good design and two tanks, one smaller than the other, to care for the small volumes usually delivered to a new plant.

Marion (4,675): The two filters (new plant) showed uneven distribution of sewage. The siphons were giving trouble. No sludge bed. Sludge from septic tanks flushed directly into the creek.

Nevada (2,686): Both filters were being bypassed at time of visit. One was still flooded from high water in the creek. The filter beds were badly overworked, operating at least three times the normal rate. In winter the beds are bypassed. The plant receives regular care.

Newton (5,165): Serious trouble with gas waste had put both the Imhoff tank and the two filter beds out of commission. The tank had been improperly constructed in the first place with holes at the bottom of the sedimentation chambers instead of continuous slots. The flat-slab cover has been removed.

Sumner (1,585): Filters permanently bypassed, since they had been constructed with their drainage system too near the level of the creek.

Tipton (2,176): Filter beds badly overworked, flooded recently and the plank distributors floated out of place. With no sludge bed the septic tanks are sludged directly into the creek. The filters are bypassed in winter. Little care.

Toledo (1,721): Both filter beds flooded from high water in the creek. In winter the plant is bypassed. No regular care.

Make Imhoff Tank Surfaces Smooth

As with septic tanks and grit chambers, so with Imhoff tanks—the flat-slab cover must be dispensed with. With some plants the side walls of the sedimentation basins must be cleaned and the slots opened once a day. With other plants once a month is sufficient. It is essential in constructing the sedimentation chamber that the surfaces upon which the solids settle should be finished smooth. The slopes of the bottoms of the sedimentation chambers should not be too flat. The slot at the bottom of the chamber should be wide enough to prevent its being clogged by sludge. One large Imhoff tank plant had been constructed without much attention to smooth surfaces in the sedimentation chambers, and ridges between the boards of the forms were in evidence. Two results are sure in such a case. First, the walls and aprons of the sedimentation chambers cannot be cleaned properly. Then, due to the fact that the sludge deposited is not all removed, some of it will become septic, and when gas-filled will rise to the surface, thus interfering with the proper efficiency of sedimentation.

The design must be so worked out that there are no sludge or gas pockets underneath the walls comprising the sedimentation chamber. Such pockets are frequently found in tanks provided with double sedimentation chambers with chimney gas vents between. The sludge and gas collecting in these pockets will eventually cause trouble by coming up through the slot in the bottom of the sedimentation chamber, thus interfering with the fundamental purpose for which Imhoff tanks are designed.

An emergency drain pipe should be so designed and constructed that the level of the sewage in the tanks may easily be lowered below the slots of the sedimentation chambers. In this way tedious and expensive pumping is avoided in case it becomes necessary to empty these chambers in order to clean the slopes and open the slots, or to remove obstinate sludge from the digestion chambers.

Every Imhoff tank ought to be constructed with such connections to water under pressure that the sludge in the bottom of the tank, together with the sludge immediately underneath the bottom of the sludge pipe, may be readily broken up and agitated.

Bypassing Sludge to Creeks Too Common

The flow line of the inlet carrying the sludge upon the bed should be so high above the surface that the sludge will not back into the sludge pipe, and thus ultimately stop it up. Distribution troughs for sludge from either septic tanks or Imhoff tanks are unnecessary. The sludge beds should be as porous as possible. An inch or two of sand upon the top of about a foot of properly graded

material is common practice in the large Imhoff plants in the East.

The practice at many plants of sludging out tanks directly into drainage ditches or creeks should be discontinued. Sludge beds should be constructed and used even if pumping is necessary. No direct bypass of sludge to creeks should be included in the design of the plant.

In at least one plant in Iowa the sludge cannot be removed from the siphon chamber without considerable labor, since during construction the inspector did not insist upon the contractor constructing a smooth floor with the proper slope. A bypass for the effluent from sedimentation tanks should be included in the design of the siphon chamber.

The word "automatic" siphon is a misnomer. While such siphons will operate automatically, occasionally for long periods of time, yet at any moment the proper alternation of the siphons may cease. Accordingly all piping, vents, blowoff traps and starting wells should be so located as to be easily accessible. In many plants in Iowa it is so difficult to get at the siphons and their auxiliary connections that they are naturally neglected. Ultimately this means trouble and expense.

A great many filter beds in Iowa are overworked. Engineers differ upon the area which should be provided. The State Board of Health has concluded that under Iowa conditions, with ordinary residential sewage from small towns, intermittent sand filters may be operated at a rate of 200,000 gallons per day. Many filter beds have berms 4 to 5 ft. wide at the top, with slopes 1½ : 1 around each individual filter bed. When beds are symmetrically located side by side much area may be saved if they are separated by sand ridges 10 or 12 ins. high. No inconvenience in operation has been found where this method has been followed consistently.

In selecting sand for sewage filters the State Board of Health should be consulted, as a study has been made of many of the sand deposits in Iowa and the requirements for filter sand have been adjusted to suit average Iowa conditions.

One common fault in the operation of filter beds in Iowa is the uneven distribution of the sewage over the surface of the bed. In general, the tile distributors, especially those consisting of a single line of tile down the centre of the beds, were found to be giving better service than plank distributors. The operators of the plants, however, need instruction as to how to alter the flow through both tile and plank distributors so that equal amounts of sewage may reach equal areas.

In case the filter bed becomes flooded, under no circumstances should holes be made in the sand so that the sewage may find its way directly to the underdrains. This was tried at Grinnell with the result that the underdrains were clogged and the filter beds put out of commission. Spading or plowing of beds should not be permitted. The surface should be stirred only to a depth of ½ inch.

Every plant, no matter how small, should have a tool house, and the superstructure of the sedimentation tanks may be so designed as to serve this purpose. This house would afford the operator protection from the weather, and here he may make the reports and carry out the simple tests which ought to be required.

The sludge levels in the sedimentation tanks should be measured regularly. The engineer should leave with the operator devices for this purpose, such as a graduated cord or wire with a weighted board or iron plate attached in such a way as to remain horizontal. No plant visited possessed anything of this kind. Certain industrial wastes must be guarded against. Grease from garages, wastes from creameries and from gas plants must not find their way directly into the sewage-treatment plant.

It is strange in how few plants any idea exists as to the one fact which is most fundamental of all—how much sewage is being handled.

The plant should have every bypass sealed by the State Board of Health. Whenever such a seal must be broken a written report, stating the cause, should be made to the board within 24 hours. For violating this rule, Prof. Dunlap suggests that a severe fine or imprisonment, or both, should be fixed by law. The bypassing of sewage-treatment plants has become a matter of course. The dictates of both law and of common sense are thereby transgressed with no compunctions of the community conscience whatsoever. The remedy recommended, though drastic, would correct much of the present carelessness and thoughtlessness.

Four preventives and remedies for the maladies of sewage-works in Iowa are suggested: (1) Proper design should be insisted on. (2) The State Board of Health should require that contracts with engineers for the design of plants should include an agreement to operate them for at least one year after completion. During this period some competent man could be trained to care for the plant, make the proper tests, and fill out reports to the State Board of Health. (3) In instructing the local operator it must be kept in mind that this individual is a more or less transitory character. Accordingly, explicit directions for each detail of operation must be made out. It is a good plan to have such directions framed and hung in the tool house. Some of the engineers of Iowa already are conscientiously leaving such directions, but in no case have they been found at the plant itself. In most instances they were filed away by city clerks and forgotten. (4) Some central authority like the State Board of Health must be in direct control of sewage-works operation and to make this effective more financial support is necessary.

GETTING REPORT ON EVERY OFFICIAL OF THE PUBLIC WORKS DEPARTMENT

Hon. Frank B. Carvell, Minister of Public Works, last week told the House of Commons that his department is overmanned under existing conditions and that he is "engaged in getting reliable reports on every official of the department throughout the country. These reports show that a large number of men are not earning their salaries."

He expressed the hope that many of the officials not required in his department could be placed on work in connection with the construction of buildings for the Military Hospitals Commission, which work is now being supervised by his department. F. N. McCrea, member for Sherbrooke, P.Q., told the minister not to hesitate to discharge unnecessary employes, claiming that there is plenty of work in the country for them.

The Railway Committee of the House of Commons, Ottawa, last week approved of the bill extending the time for the construction of the Georgian Bay Canal until May, 1921.

George H. Gooderham, chairman of the Toronto-Hamilton Highway Commission, told a meeting of ratepayers last week that the commission may have a surplus left after the construction of the highway is completed. The meeting was called to bring to Mr. Gooderham's attention the fact that the cost of the section between Mimico and the Humber Bridge falls heavily upon only forty-eight ratepayers. Mr. Gooderham said that the surplus may be applied to the relief of these ratepayers.

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Principal Contents of this Issue

FERTILIZER VALUE OF ACTIVATED SLUDGE

EXPERIMENTS have been conducted by the Department of Public Health of the city of Toronto to determine the value of activated sludge as a fertilizer. The results of these experiments are described in this issue in an article by Col. Nasmith and Mr. McKay. This article is of intense interest, not only to engineers who have to solve sewage disposal problems, but to the general public, as it may point out a way to prevent the "working out" of farms which has resulted in the ruin of such vast tracts of land in nearly every quarter of the globe.

To-day we are thinking of production and conservation in a large way. We are devising means to obtain nitrates from the air, for explosive and fertilizing purposes, but we should not forget that in every country where there is water-carried sewage, large amounts of the nitrogen of humus-evolving elements are carried away to sea. In this way are lost materials which if available, would maintain or increase the fertility and productivity of our soil. For this reason, any facts bearing upon the actual fertilizing value of this comparatively new material, activated sludge, are most interesting and timely, especially in view of the possible need for even greater food production in the future.

If a fair proportion of the valuable constituents in our sewage can be retained and returned to the land in a form assimilable by plants, we have to some slight extent at least, solved the food production problem.

Though a great increase in yield results from fertilizing vegetables with the various sludges, as compared with the yield from unfertilized soil, no emphasis is given to this by the authors. They have, in order not to show too striking results, compared the yield from soil fertilized with activated sludge, with that from soil fertilized with equal quantities of barn-yard manure. Even so, the increases due to activated sludge are so extraordinary that the results are almost startling until one recalls what Chinese gardeners accomplish by their intensive methods of cultivation.

It now remains, as the authors suggest in their opening paragraph, for someone to solve the problem of dewatering activated sludge, in order to make its use commercially feasible. Centrifuging has already given promising returns. With the world's growing knowledge of the chemistry of colloids, the solution of the dewatering problem may not be far distant.

THE GOOD ROADS CONGRESS

ALTHOUGH urged by many to suspend operations until after the war, the directors of the Canadian Good Roads Association have wisely decided to "carry on" and to hold their fifth congress next week at Hamilton, Ontario. There are many problems which such a congress of engineers and road experts can solve. They should be able to decide upon recommendations to the government which will be of value to the nation. During the past three years and nine months of war, the country has learned that the quick and economical movement of men and material depends largely upon the state of repair of streets and highways.

As pointed out recently by one of our American contemporaries, this sort of an argument may be given too much weight in some communities in an endeavor to get improved pavements at general city expense on residence or minor traffic streets. To prevent this, there may have to be a judicious extension of the practice of assessing the cost of pavements upon the property directly benefited. C. A. Mullen, in an article in this issue, strongly urges that the whole cost of construction and maintenance of pavements be paid through a wheel tax.

The program of the road congress at Hamilton is largely directed, naturally, to war problems. There will probably be much discussion of the best means of repairing badly worn existing pavements where it may be advisable to suffer heavy maintenance charges rather than to provide an entire new pavement, in order that transportation, materials and capital outlay may be conserved so far as possible until the end of the war. In this connection the article in this issue by L. McLaren Hunter on "The Maintenance of Asphalt Pavements in Ottawa" is of timely interest, as it shows what can be accomplished by prompt and vigorous attention to maintenance. Although the city of Ottawa had more miles of pavements to maintain last year than in any previous year, the total yardage of repairs was less, due to the rapidity with which the city engineering department attended to small holes, which, if neglected, would soon have been enlarged.

Since the beginning of the war, there have been two reversals of public opinion in regard to expenditures upon roads and streets. "Business as usual" was the universal slogan throughout the whole country immediately after war was declared. For several weeks we carried the slogan at the head of our editorial column, as did scores of other journals and newspapers throughout Canada. We all soon saw, however, that "Business as usual" was merely a phrase and that it was actually an impossibility. Public opinion then reverted to an extreme program of economy. Everything in the nature of capital expenditure was condemned, regardless of any resulting daily loss or

inconvenience, and regardless of any increased ultimate cost which might be created by the "saving."

Not so very long ago there started another change in the public attitude toward paving expenditures. People began to realize that highway work is not a non-essential. There arose a better appreciation of the place of the highway in the economic life of the nation. Railroad magnates who had often before fought highway expenditures, began to talk about highways as feeders for their railroads, and plans for elaborate highway systems became a part of their visions for the future growth of their railroads. W. F. Tye, of Montreal, was probably responsible for the first enlightenment in this direction, when he pointed out that one of the factors in the non-success of the Canadian Northern and Grand Trunk Pacific railways, lay in the fact that there was a lack of well-constructed highways to feed their main and branch lines.

In the United States the government has appointed a Highways Transport Committee to decide how highways may best be handled for military and economic welfare. The Canadian Road Congress should be able next week to do for this country much of the work that the Highways Transport Committee has done in the United States.

"The agitation regarding highway work has produced a very beneficial effect for the future," says "Engineering News-Record," of New York. "For all time the place of the highways in the transportation system of the country is settled. This is a real gain and one that those who have the interests of highway development at heart should not belittle. In the past there has been inveighing against 'pleasure roads' and ill-concealed prejudice in some quarters against motor transportation. That is definitely and finally dead. Highways are an economic necessity for the nation. Sensible men have known and recognized it for a long time. Now the country at large has been forced to its recognition and, insofar as that recognition has been secured, all the stress and strife that we have passed through during the last year have been more than paid for.

"This accomplishment—the placing of the highway system of the country in its correct economic and military light—will mean for highway development after the war is over an expansion such as we have never dreamed of in the past. We have been looking with amazement at the increase in expenditures for highway work during the past decade. Who can doubt that these are the merest beginnings when measured by the development that will come after the war is over?"

PERSONALS

A. G. Dalzell, A.M.Can.Soc.C.E., member of the Royal Sanitary Institute, engineer in charge of the sewer department, Vancouver, B.C., has resigned from the engineering staff of that city.

Chas. Brakenridge, A.M.Can.Soc.C.E., engineer in charge of roadways and paving, Vancouver, B.C., has resigned from the engineering staff of that city and is considering entering private practice there.

Wilfrid Tourigny, who before entering the army was employed in the road maintenance department of the Canadian Pacific Railway, has been wounded. He is the eldest son of H. B. Tourigny, district engineer, Public Works Department, Three Rivers, Quebec.

Lieut. Alexander McKenzie West, B.A.Sc., '10, University of Toronto, has received the Military Cross "for constructing a bridge under severe fire." Lieut West's home is in Hespeler, Ont., but he enlisted in 1915 from North Vancouver, where he was engaged as city engineer.

Capt. Norman C. Millman, B.A.Sc., '13, graduate of the School of Applied Science, University of Toronto, has been awarded the Military Cross in recognition of his services with the Royal Flying Corps. Before going overseas in December, 1915, he was on the staff of the Hydro-Electric Power Commission of Ontario. In January last he was promoted to flight commander with the rank of captain.

Stanley Shupe, B.A.Sc., has resigned as town engineer of Dunnville, Ont., in order to accept a position as engineering inspector with the Canadian Fire Underwriters' Association, Toronto. Mr. Shupe's new work will have special reference to the layout of municipal waterworks. He was also engineer for Haldimand county and for several townships in the vicinity of Dunnville. He has also resigned these positions. Frank Barber, consulting engineer, Toronto, has taken over all of Mr. Shupe's unfinished work pending the appointment of a successor.

Col. Charles H. Mitchell, C.M.G., has been presented with the decoration of the Order of the Crown by the King of Italy, in whose country he was recently serving as general staff officer (Intelligence) with the 2nd British Army. He is a graduate of S.P.S., Toronto, and prior to going overseas as chief of intelligence in the 1st Canadian Division, was following his profession as consulting engineer in Toronto. Col. Mitchell received the D.S.O. shortly after the second battle of Ypres, and since then has been given the French Legion of Honor, the Belgian Order of Leopold and the Croix de Guerre. He recently returned to the western front, after having been in Italy since last fall.

STANDARD REVERSED CURVE

(Continued from page 385)

tersecting roads equal the main road in importance, or when this is even a future possibility, provision for suitable connections should be taken into account in the design of the proposed improvement. Only in such cases, then, must the above design be either extensively modified or entirely disregarded.

Taking into consideration the relatively few instances where such a modification would be needed and realizing that local conditions would further modify any fixed rule, it is not considered advisable here to enter into a discussion of the numerous details of such a design. It could best be handled as a special case by the district engineer when working up plans. Details based upon variations from the standard design, as influenced by local conditions and details of construction, are also properly left to the judgment of the district engineer, to be worked out in accordance with the usual practice of the department.

CORRECTION

A typographical error occurred in printing Mr. Breithaupt's review of the book, "Relief from Floods," which appeared on page 372 of our last week's issue. The capacity of the largest reservoirs in the United States, namely, those on the headwaters of the Mississippi River, is 96 billion cubic feet. The word "million" accidentally appeared in the review instead of the word "billion."

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

TRACK ALLOWANCE PAVING

Methods in Vogue in Toronto—History of the Progressive Development of Foundation and Surface Work—Granite Block the Standard, But Experiments With Asphalt Have Given Promising Results—Radical Changes in Last Twenty Years

By MURRAY ALEXANDER STEWART
Roadway Engineer, Department of Works, Toronto

TRACK allowance surfaces in Toronto are now divided into three chief classes: (1) Dressed granite block, which may be said to be our standard pavement for use between street railway tracks; (2) creosoted wood block, which is used on all bridges and viaducts, and of which a considerable quantity has been laid also on street track allowances; and (3) sheet asphalt, with which we are now experimenting. Other types of surfaces have been tried at various times but have been found unsatisfactory for one reason or another, and all Toronto work is now confined to these three types.

Sheet Asphalt

The use of asphalt for the paving of track allowance areas at the present time may be said to be merely in the experimental stage, although in past years it has been tried and has not been successful. That was partly due to insufficient knowledge of asphalt mixtures and to inadequate foundations.

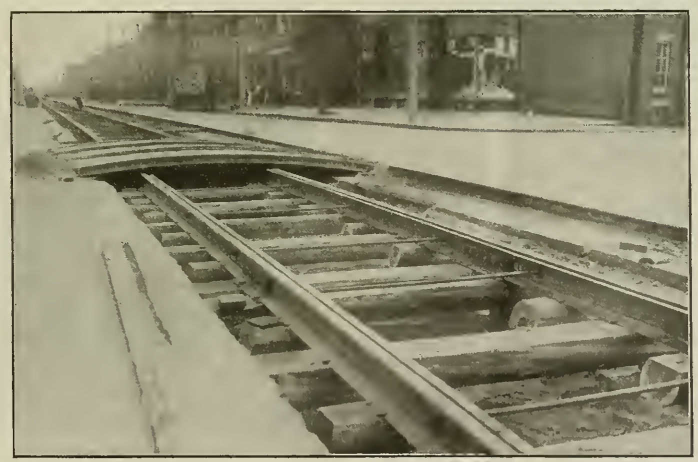

Fig. No. 1—Dundas Street Track Reconstruction; Concrete Foundation, Sheet Asphalt Wearing Surface. One Track Completed; Ready for Concreting Other Track

In 1914 a few hundred feet of track allowance on College Street, extending easterly from Bathurst Street, was paved with asphalt. The binder course was 1½ inches thick, proportioned approximately as follows:—

¾-inch stone, 82%; sand, 13%; asphaltic cement, 5%.

The asphalt, sand and stone were required to meet the general specifications of the city. Upon this binder course was placed a wearing surface two inches in thickness, mixed in approximately the following proportions:—

Asphaltic cement, 10 to 18%; sand, 85 to 67%; mineral dust, 5 to 15%.

The binder course was rolled with a roller weighing not less than five tons and the surface course was first rolled with a five-ton roller and, as soon as the material would bear it, with a roller weighing not less than eight tons.

In 1915 the city constructed, in co-operation with the Toronto Railway Company, a new track on Lappin Avenue. It was decided to use creosoted wooden block placed upon a foundation of 1:3:6 concrete. As the work progressed, difficulty was experienced in obtaining deliveries of block, and in order to be able to complete the work before winter, it was finished with asphalt. To the present time this pavement has shown excellent results.

In 1917 we decided to use asphalt again, this time in work of considerable area—the Dundas Street track—as our experiences had lead the department to the belief that with sufficient care an asphalt pavement could be laid which would stand up in track allowance in a satisfactory manner.

The part of the foundation which is beneath the base of the rail did not change, of course. Inasmuch as a 7-inch rail was used, however, and as the thickness of the asphalt totalled 3½ inches, consisting of 1½ inches of close binder and 2 inches of wearing surface, it was necessary to introduce above the ties an additional slab of concrete 3½ inches thick. This was placed after the concrete foundation had set and dried out to a considerable extent, in order to leave the bond weak between the two courses, thus permitting the removal of the upper course should it

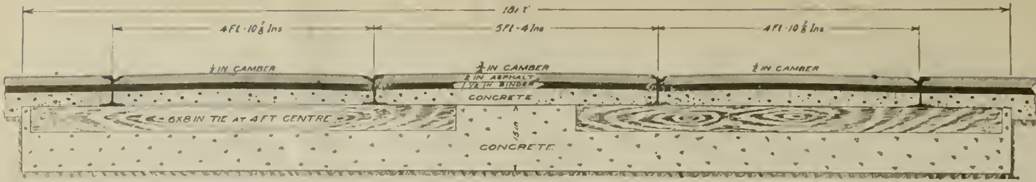

Fig. No. 2—Asphalt Pavement with 7-in. Girder Rail, 1917 Construction

be desired at any time to substitute a pavement of greater depth than the asphalt.

Before placing the asphalt and after the entire foundation for it had been built, the web and under side of the head of the rail were painted with hot asphalt. The filler strip was eliminated. The binder and top course were

Fig. No. 3—Binder Course for Asphalt Pavement, Lappin Avenue. Devil Strip and Far Track are Finished

then placed successively, care being taken to tamp the material thoroughly beneath the head of the rail before rolling. The appearance of this track allowance is excellent at present and we hope that it will continue so for a number of years to come.

Figures 1, 2 and 3 illustrate the method of construction with asphalt.

Creosoted Wood Block

The first use of treated wooden block for the pavement of track allowances was in 1911. For some years following this material was used to a considerable extent. The wooden blocks were usually 3 inches in width, 4 inches in depth and 8 inches in length, treated with 14 pounds of creosote oil per cubic foot of wood. These blocks are provided with lugs at one side and one end, if desired. After they were brought to a true surface on a sand cushion, pitch filling was immediately applied.

This filling was done only to the extent of one-half the depth of the block, and in order to ensure the least possible amount of pitch remaining upon the surface of the blocks, hot iron squeegees were used to sweep the pitch into the joints. The upper half of the joint was then filled with sand, and a coating of gravel or stone chips was spread over the entire surface and allowed to remain for some time.

Difficulty, however, was experienced in some cases by the popping up of single blocks and the heaving of small sections; considerable wear in some instances also developed, and the use of an improved granite block has been adopted for the last two years.

Figure 5 shows the method of pitch-filling a wood block pavement. Figure 7 shows wood block being laid on the dry mortar cushion.

Granite Block

The granite block are well cut and present a comparatively smooth surface, the joints being reduced to a minimum by the character of the cutting. The sand cushion upon which pavements of this nature were formerly laid, has now been replaced with a mortar cushion,

Fig. No. 5—Pouring Tar into Joints of Wood Block Pavement, Ossington Avenue

and wood treated with creosote has been substituted for the mortar casing with which the hollow of the rail was formerly filled. To date, probably the best results yet experienced by this city in track allowance work have been obtained by this form of construction.

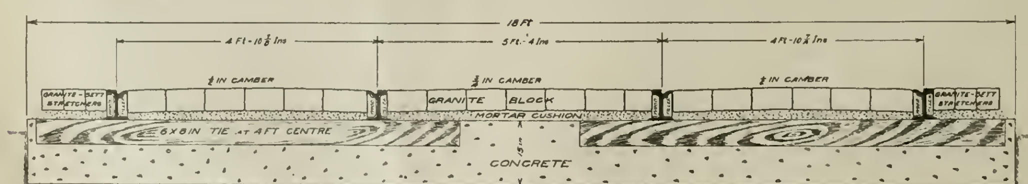

Fig. No. 4—Granite Block with 7-in. Girder Rail, 1915 Construction

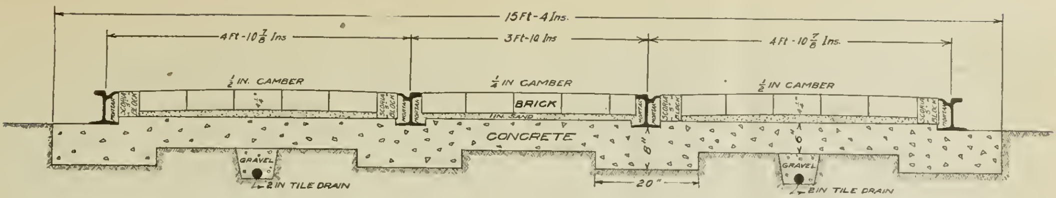

Fig. No. 6—Brick Pavement, with 6½-in. Girder Rail, 1895 Construction

In carrying out the construction of granite block track allowance on a street where an old track allowance had existed before, the first procedure, according to present practice in Toronto, is to lay a temporary track at one side of the old structure, for such a length as may be convenient, connecting with the nearer old track by means of turn-outs.

Prior to 1912 all reconstruction work was carried on while the cars were operating over the line, and it was therefore impossible to obtain the best results. In 1912 arrangements were made with the railway company whereby we were allowed to build a temporary track, with turn-outs at each end, on every job.

The traffic is turned onto the temporary track, and the section of the old track, which is thus relieved from traffic, is removed. The excavation for the new track is then made to a depth of fifteen inches beneath the bottom of the rail, or, in the case of a seven-inch girder rail being used, to a depth of twenty-two inches below the grade.

Fig. No. 7—Laying Wood Block on Dry Mortar, Lappin Avenue and Dufferin Street

As soon as the sub-grade has been properly prepared, the new steel, ties and blocks are placed, the ties alternating with the bevelled blocks at 4-foot centres. After the rails have been securely spiked to the ties, the whole structure is blocked up and the rail properly lined and topped.

Concrete of 1 : 3 : 6 proportions is then placed for the entire width of a single track and one-half the width of the devil strip, for a depth of 9 inches, the surface of the con-

Fig. No. 9—Laying Granite Block on Mortar Bed, King Street

crete being in contact with the bottom of the ties. After the concrete has set to some extent, but before it has thoroughly dried, the second course of concrete is placed, and consists of filling in the spaces between the ties and blocks until level with the top of the ties. Before the placing of this second course, should it be evident that any shrinkage of the first course of concrete has taken place beneath the ties, the concrete adjoining the ties is thoroughly tamped in beneath them.

The next step in connection with the work is to place the filler strips, which consist of pine strips cut to the shape of the hollow of the rail and to convenient lengths. No portion of the strip projects beyond the head of the rail. These strips, before placing, are creosoted. After the strips have been placed, and the concrete foundation thoroughly set and sufficiently dried out to permit the work to be proceeded with, the cushion course is placed.

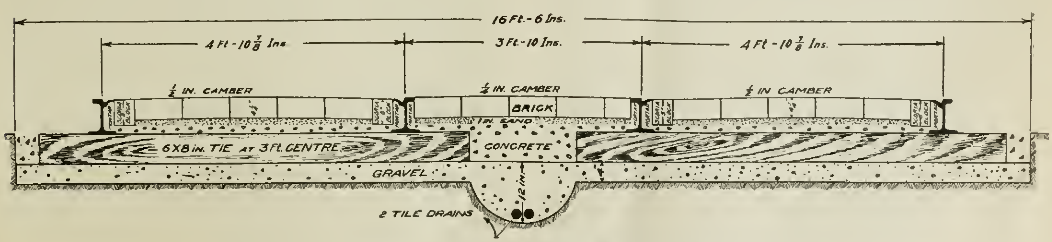

Fig. No. 8—Brick with 6½-in. Girder Rail, 1893 Construction

The latest work which we have done provides that this cushion shall be either of a dry mortar mixed in 1 to 4 proportions, or concrete consisting of 1 : 3 : 6 mixture; the stone constituent of which is ⅜-inch stone. Upon this cushion, which, if of mortar, must be dampened immediately, the granite blocks are laid and brought to a true surface by pounding, after which the grouting is immediately applied a sufficient number of times to insure that the joints are thoroughly full. The grouting consists of 1 to 1 mixture, and is mixed in an enclosed box and constantly agitated. It is applied to the pavement by means of scoop shovels.

The work is allowed to stand for at least two weeks before cars are permitted to operate over it. Then the other track is reconstructed, additional turn-outs being placed to divert the traffic to the newly constructed track.

Figures 4 and 9 illustrate the most advanced type of granite block track allowance.

Foundation

In the early days of the street railway company's franchise, the necessity for what is now known as a permanent pavement was not so urgent as it is at the present time,

Fig. No. 10—Type of Structure Used on All Work Since 1911, Ties and Bevelled Blocks Alternately Spaced at 2-Foot Centres

and types of pavement, the laying of which has long since ceased, were permitted. This is particularly so in the case of cedar block, of which a great deal was laid in the past.

The greatest development, however, has taken place in the foundation supporting the pavement. The early types provided for a course of gravel beneath the ties and concrete between the ties, the pavement being placed upon the ties and concrete. It will readily be seen that such a structure, permitting as it did a great deal of movement of the rail, promoted very rapid deterioration of the pavement.

A cross-section of a typical track allowance structure of 1893 is shown in Figure 8. It will be seen from this that after the subgrade had been prepared, a trench, 12 inches deep below the bottom of tie, was made down the centre of the excavation and two rows of 2-inch tile drain placed. This trench was then filled with gravel, as was also the entire excavation, to a depth of 4 inches. Upon this gravel the ties were placed at 3-foot centres and the rails spiked thereto. The spaces between the ties were then filled with concrete, which was also carried around the ends of the ties to the outside edges of the track allowance area. Inasmuch as the ties were 6 inches in depth, the concrete was the same, with the addition of as much more on top as was necessary to insure a 1-inch cushion of sand beneath the bricks which constituted the surface of the pavement.

Immediately before laying the surface, the sand cushion was struck to a true surface with a template, and the hollow of the rail filled with a very stiff cement mortar. This was so finished as to present a perpendicular face, which dropped from the outside points of the head of the rail. The laying of the pavement was at once proceeded with, a row of scoria blocks being first laid as stretchers, or in some cases alternately as header and stretcher, and the bricks then laid in courses, at right angles to the line of the work. The bricks were then grouted in the usual way. Other materials, such as cedar block, asphalt block and stone block, were used on various works, but the above serves to illustrate the general practice at that time.

Radical Changes in Foundation

This method of construction in time proved very unsatisfactory, and in 1895 a radical change was made in the foundation, although the same methods obtained with respect to the surface. Instead of placing ties at 3-foot centres and filling between with concrete, no ties were used and a concrete base was placed for the entire area of the track allowance. This base was 8 inches in thickness for a width of 10 inches on each side of the centre line of each rail and 6 inches in thickness in the centre. (See Figure 6.) This type of foundation was found to be inadequate, and it was thought that there was not sufficient weight of concrete beneath the rails. For that reason, in 1905 the foundation was changed to the extent of making that portion which lay beneath each rail 12 inches in depth instead of 8 inches, otherwise the dimensions were the same. The laying of the pavement was carried out as has been previously described.

In 1906 the track allowance was widened so that the width of strip between the tracks became 5 feet 4 inches instead of 3 feet 10 inches. This was done in order to permit the operation of wider cars. The types of pavement, however, which were available for work of this character were reduced considerably, and practically all the work laid at this time and for some years after consisted of granite block, vitrified brick and scoria block.

About this time a considerable amount of T-rail was used, which altered to some extent the method formerly adopted in paving. It was impossible, of course, to lay the pavement directly against the head of the rail as heretofore, as provision had to be made for the flanges of the car wheels. To this end, what were known as half-and-whole flange blocks were used, and were laid alternately in order that a proper bond might be made with the balance of the pavement.

These blocks, which consisted of either granite or scoria (molded slag block), were similar to the ordinary rectangular blocks, with the exception that one corner for the full width of the block was cut out for a sufficient depth and width to permit the small end thus created to be placed beneath the head of the rail and lie solidly against the web. In this way a groove was established for the accommodation of the wheel flange. The blocks were bedded in 1 : 4 cement mortar, and the mortar casing used with the girder type of rail was done away with. It may be added, however, that the use of the T-rail has for the last few years been abandoned.

The foundation just described, in turn developed certain weaknesses, and was replaced in 1911 by a slab, 12 inches in thickness, for the entire width of the track allowance area.

The use of ties was also resumed, as it was found that upon those tracks where no ties had been used great difficulty was experienced in keeping the rails in proper alignment and to proper grade. At this time steel ties were first discussed, and they were tried out on certain works, being placed at 6-foot centres and secured to the rail by means of clips, bolted to the ties and overlapping the base of the rail.

Heavier Concrete Foundation

Another alteration took place last year on certain track allowances, built in the most heavily travelled parts of the city, the foundation being increased to 15 inches of concrete on straight track and 18 inches beneath all intersections. This foundation was laid in two courses, the first course being 9 inches in depth and the top coming into contact with the bottom of the tie. After the concrete had set, but before it had thoroughly dried, the second course of 6 inches was placed, the concrete of the first course being thoroughly pounded beneath the ties and any apparent shrinkage taken up by floating in a cement grout.

The use of steel ties was also abandoned on this later work, as difficulty was experienced in holding the rails securely with the clips and in making repairs, and wooden ties and bevelled wooden blocks, alternately spaced at 2-foot centres, as shown in Figure 10, were again introduced. This foundation has been in use on all work since 1911, and at the present time there is, so far as can be seen from the excellent results obtained, no occasion for alteration.

WHAT ARE NON-ESSENTIAL INDUSTRIES?

CANADA'S main business is the winning of the war, and the bending of every effort both of labor and capital to the attainment of victory. "Nevertheless, such a programme, fundamentally important as it is, must not obscure the plain fact that victory will be achieved mainly, if not solely, through our ability to wear out the enemy," says "The Monetary Times," of Toronto, in a recent issue. "And this cannot be accomplished by impairing the industrial power of the nation.

"In some quarters it is considered highly unpatriotic to spend on so-called luxuries, on automobiles, silks, and commodities of like nature. In brief, the argument is that reserves of capital and labor should be concentrated on the production of foodstuffs and munitions of war alone—that spending money on comforts and luxuries is entirely reprehensible. This logic is valid only insofar as capital and labor can be employed on war work. Ceasing to spend on automobiles, pianos, gramaphones and other so-called 'luxuries' would result merely in causing unemployment, both of labor and capital. Idle labor and closed factories never yet paid taxes, or helped to sustain the productive energy of any nation.

"Canadians have been informed that the government will require some $516,000,000 during the current fiscal year on war account alone. It is only from earnings, interest and profits that this vast sum can be procured. Depositing funds in the savings banks is not exactly hoarding; the banks must use these funds for the support of industry or forego profits. If, however, spending on luxuries is curtailed, it will be impossible to find productive use for this capital. The main argument for saving, in the sense of hoarding, in order that Victory Bonds may be bought, is patently absurd. Manifestly, the full employment of the entire reserves of the country's capital and labor is requisite for the support of war loans, and a *sine qua non* for the winning of the war.

"Mr. S. Hare, president of the Packard Motor Company, in a speech recently delivered in New York, drew sharp attention to this important subject. He made public for the first time the fact that the Liberty motor, adopted by the United States government for all its aeroplanes, was the invention of the Packard Company. On the perfecting of this motor three years were spent by the engineers in Mr. Hare's employ; and it was a 'non-essential' industry that, in this particular at least, saved the situation for the American government. Mr. Hare drew attention to the undoubted fact that there was, after all, a definite limit to the number of men that could be employed upon specific war work; and that so long as shipbuilding, munition-making, and food production did not suffer from lack of labor, there was no logical reason for slowing down those industries engaged in turning out the ordinary products of peace.

"The exchange situation between Canada and the United States requires careful investigation and adjustment. It may be necessary to curtail our importations of luxuries; but that fact, arising solely out of the problem of financing our foreign trade, should not lead to confused thinking on spending and saving within Canada itself; for saving, manifestly, can be achieved only through the productive process."

CENSUS OF MANITOBA ENGINEERS

A. W. SMITH, secretary-treasurer, Manitoba Branch, Canadian Society of Civil Engineers has sent a circular letter to engineers throughout Manitoba, advising them that the council of the society has requested him to obtain a complete census, so far as possible, of all the men engaged in the engineering profession within the province. For that purpose his letter is accompanied by a printed card with spaces for filling in name, date of birth, birthplace, nationality, position, address, etc. Every engineer is requested to add on the back of the card the more important experience that he has had and the particular branch of engineering that he is following.

The engineers of the Toronto-Hamilton Highway Commission appeared before the Ontario Railway Board on May 2nd and presented their stress sheets showing the strength of the four bridges which they propose to erect along the highway. The board ordered them to submit the figures to the municipalities and to report on May 14th.

The Crescent Concrete Co., Ltd., in liquidation, has re-opened offices in the Temple Building, Toronto, by special arrangement with the company's creditors, and has resumed business. It has been awarded a contract by the Imperial Oil Co., Ltd., for relining four large gasoline tanks at West Toronto with a layer of cement mortar, or "gunite," by the cement-gun method.

By the recent amendments to the Vancouver and Districts Joint Sewerage Act, the board shall consist of a chairman and the mayor and reeve of each municipality within the sewerage district. The new board for 1918 will consist of Chairman Staples, Mayor Gale (of Vancouver), Reeve H. M. Fraser (of Burnaby), Commissioner Gillespie (of South Vancouver), and Reeve Fletcher (of Point Grey).

The following have been named as county roads in Collingwood Township, Grey County:—The lake shore road across the township, the tenth line from Thornbury to a point one mile south of the Heathcote sideroad, the Heathcote sideroad from the 10th west to the Collingwood townline, the townline south through Heathcote one mile to connect with the Euphrasia system; the eighth line from the lake shore road to Ravenna; the Pretty River Valley road from Osprey to Nottawasaga, and 9-10 sideroad, also the mountain road, 15-16, from the 4th concession to Nottawasaga.

Letters to the Editor

Engineer Worth Less Than Mechanic?

Sir,—The accompanying newspaper clippings may be of interest in view of the movement for better recognition of and higher remuneration for the professional services of civil engineers. They also serve as a good illustration of the relative standing in the way of pay of the average engineer and mechanic.

Clipping No. 1, from the Halifax Evening Mail of April 26th, shows how reckless some people can be in the expenditure of public money. Can anyone imagine anything so foolish as the expenditure of $1,400 a year, or $26.92 a week, on the very unimportant work connected with a town's engineering problems?

A Permanent Engineer For Dartmouth

Councillor Lynch Gave Notice of Motion at Last Night's Council Meeting That He Would Move for the Appointment of an Engineer at $1,400 Per Annum.

DARTMOUTH, April 26—A permanent engineer may be appointed by the Dartmouth Town Council. At a special meeting of the council last night a notice of motion was given by Councillor Lynch that at the next meeting he would introduce a resolution recommending the appointment of a permanent engineer at $1,400 per annum. He considered the town was in need of the services of s an official. An engine kept very h ann

Mechanic Wanted

TO Repair and Keep in Running Order, Ford Cars. Wages, $30.00 per week. Apply,

UNGAR'S LAUNDRY

Clipping No. 2, an advertisement for a mechanic to repair Ford cars, wages $30 per week, is an altogether different proposition, because it is from a business firm that understands that satisfactory results can only be obtained by the employment of competent men in each department. The inference is obvious. Dartmouth does not place its town planning and engineering problems on the same plane as a business firm places the repairs on its low-priced cars. When one considers the long and expensive training in school and college required by an engineer, one concludes that "there is something rotten in the state of Denmark," or in other words, in the ability of the civil engineering profession to impress on the world at large the importance of its services.

E. F. HANDY, M.Can.Soc.C.E.

Halifax, N.S., April 30th, 1918.

Federal Engineering Service

Sir,—I am gratified that you found space in the columns of your issue of the 25th ult. for my rather long communication regarding "A Federal Engineering Service," but I am sorry to observe that in one rather important particular you have misapprehended the presentation of my views.

In your editorial article on page 375, commenting on my letter, you have stated that I suggest "closing" the profession, which is not the case. I certainly advocated the "closing" of the federal engineering service to engineers who are not members of the Canadian Society of Civil Engineers, which is a very different proposition to "closing" the profession of engineering generally. It is quite true that in Canada membership in the Canadian Society of Civil Engineers is the only guarantee or certificate that a man is a properly qualified engineer, but there are many properly qualified engineers in Canada who are not members of the Canadian Society of Civil Engineers. It is a pity that this is so, but it is a fact nevertheless. A man may be a capable and experienced engineer, doctor or lawyer and still lack a diploma or other documentary evidence of his qualifications.

To make engineering a "closed" profession in Canada is another matter, and one that has engaged the serious study and attention of the Canadian Society of Civil Engineers for a number of years. As you are aware, the profession is "closed" in the provinces of Quebec and Manitoba by virtue of provincial acts passed some few years ago, and unsuccessful efforts have been made to accomplish similar results in other provinces.

Whether the "closing" of the profession in Canada, thus putting it on all fours with other professions, is a wise step or not, is a matter in regard to which there is wide diversity of opinion among the engineers of the country. I have little or no information as to the practical operations of the "closing" act in Manitoba, but in the province of Quebec it has not by any means been an unmixed blessing or an unqualified success, from all that I have heard. In the province of Quebec the Canadian Society of Civil Engineers has been compelled to admit to its roll of membership a number of men who have no claim thereto beyond a legal interpretation of the letter of the act. I believe there have been no prosecutions for the illegal practice of engineering in that province, because a conviction would be practically impossible, and a successful prosecution would probably result in the repeal of the act, and the reversion to the *status quo ante*. Nay, to a worse state, because unfortunately the repeal of the act would not repeal the elections of the undesired to the Canadian Society of Civil Engineers.

I confess that a number of years ago I was strongly in favor of the "closing" of the profession by legislative enactment, and, with other Nova Scotian engineers, I worked hard to get a bill through the legislature of the province. The House of Assembly passed the bill, but in the legislative council captious and unreasonable opposition caused it to run on the rocks. Since that time I have modified my views, though not radically changed them. On the face of it there seems no good reason why engineering should be in a different and inferior position, as to legal status, recognition and safeguards, to other professions, but there are many and grave practical difficulties in the way of a change in existing conditions.

In Great Britain the position of the engineer is as in Canada. The law does not prescribe membership in the Institution of Civil Engineers as an indispensable condition precedent to the practice of his profession, but unless he is a member he might as well saw wood as to try to get professional employment. But the Institution of Civil Engineers has been established for one hundred years. It has about 7,000 members, scattered over the globe, and it is par excellence the paramount organization of engineers of the world. It is for our society, by a steady and continuous elevation of the standard of the profession, by the exercise of rigid discrimination in elections, and by all other legitimate means, gradually to attain a corresponding influence in and upon the profession in Canada.

I do not wish to appear greedy of space in your admirable journal, but I should be glad if you could find room for this letter for the purpose of correcting any impression among my professional confreres that I advocated the "closing" of the profession in my letter regarding a federal engineering service.

C. E. W. DODWELL,
M.Inst.C.E., M.Can.Soc.C.E.
District Engineer, Public Works Dept.
Halifax, N.S., May 1st, 1918.

An Oversupply of Engineers

Sir,—I was very pleased to see in *The Canadian Engineer* of May 2nd a complete, detailed report of the meeting of the Toronto Branch of the Canadian Society of Civil Engineers. I believe that the technical press is going to play a very important part in the movement which has recently been started by the Canadian Society of Civil Engineers and some other engineering societies to improve the status of the engineer in Canada, and I am sure engineers will not fail to appreciate the importance of such reports, which tend to serve a double purpose. In the first place, they give an opportunity to those who could not attend the meeting to acquaint themselves with the views expressed there; and in the second place, they enable those who took part in the discussion to carry on the discussion still further and probably more extensively than could be done at the meeting.

One of the statements which I think deserves some further discussion is that made by Mr. Milne in connection with the fourth resolution, that "the main trouble with engineers is that some other man is always willing to take one's job at less money." This condition is probably due chiefly to two causes: (1) the low standard of ethics that exists among engineers, and (2) an occasional over-supply of engineers. Although the Canadian Society of Civil Engineers has an established code of ethics, it is regretable that most of the clauses therein apply only to perhaps 15 or 20 per cent. of the members of the profession, who are in private practice, but do not apply to the large number of employed engineers, who make up perhaps 80 to 85 per cent. of the membership of that organization. There are clauses covering the relation between one consulting engineer and another with respect to a client, and clauses covering the relation between the consulting engineer and the public. But there is not a single slause covering the relation between one employed engineer and another or the relation between employer and employee, although it is really these engineers who make up the large majority of the members of the profession.

Among all the trade unionists, the taking of some one's job at a lower wage is considered as a violation of ethics. Engineers, who are professional men, surely should have a standard of ethics even higher than that of the trade unionist. And yet we find quite frequently, as Mr. Milne states, that engineers do commit this violation; and this, no doubt, tends to lower the standard of the profession in general.

In order to improve the conditions of the engineer, the standard of ethics among engineers must be improved. And one of the main objects of the newly organized Canadian Association of Engineers is to raise the standard of ethics among engineers in Canada, which would necessarily lead also to better co-operation among engineers.

An over-supply of engineers, several men waiting for the same job, may sometimes cause an engineer to violate his ethics and outbid the other fellow from his job. But an over-supply of engineers is due to a considerable extent to a wrong conception that exists among students as to the exact conditions of the profession.

Probably no other profession is so grossly misrepresented to the young students as the engineering profession, with the result that after graduating and finding out the true conditions, many have to turn to something else where they can earn enough to make a living.

Engineering societies, whose duty it should have been to check such misrepresentation and to guard the interests of the profession, have so far done very little in that direction and certain private interests have utilized such misrepresentation for their own personal benefit.

Last year, for instance, a general alarm was raised in the United States because it was found that the attendance in the engineering colleges had become somewhat decreased in recent years, and a full campaign was practically organized for the purpose of increasing such attendance. In the first place, the government was asked to exempt engineering students from the draft law. Special funds were established in order to help poor students to take up courses in engineering. High school graduates were appealed to and the future of the engineer was pictured before them in the most beautiful and attractive colors. Parents were urged in the name of patriotism and everything else to advise their sons to take up engineering as their vocation. A certain university went even to the extent of issuing a special publication which they distributed among the high school students and in which they stated definitely that students ought to take up engineering as their profession because engineers are getting incomes of from $5,000 to $10,000 a year!

A similar campaign to that of the United States is now proposed for Canada. In the recent report published by the Joint Committee of Technical Organizations they make suggestions of special funds to be established for the purpose of increasing the attendance in engineering schools. And the question naturally arises whether it is necessary to take special pains to increase the supply of engineers in Canada. Does any one know of any important engineering work which is being held up because of lack of engineers to carry out the work? As a matter of fact, there are a number of engineers who are at present working on temporary jobs at miserably low salaries and are just waiting for something to turn up, while many others have left the profession entirely.

Now, if such are the existing conditions, is it just to induce others to take up a profession when many of those that are in the profession regret that they have ever taken it up? Would it not be more proper to acquaint the prospective students with the true conditions of the profession? Let them know that the average engineer does not even dream of $5,000 a year income; let them know that there are among our ranks men who have been in the profession 25 or 30 years, full members of the Canadian Society of Civil Engineers, capable men who have grown gray and old at engineering work, working at salaries of $1,500 or $1,600 a year. Let the students and their parents know these things and let them use their own judgment as to the profession they would choose. If the societies would put before the students the true conditions of the profession, there would not be any over-supply of engineers.

HYMAN GOLDMAN.
Toronto, Ont., May 6th, 1918.

EFFICIENCY IN ROAD DRAINAGE*

By N. B. Garver
Associate in Civil Engineering, University of Illinois, Urbana, Illinois

WATER is the worst enemy of good roads. A water-soaked subgrade precludes the possibility of a permanent road surface just as surely as quicksand under a bridge pier makes the superstructure unstable. An earth road that is good when dry may become very bad when it is soaked with water and has been broken up by the tramping of horses' feet and the wheels of vehicles. In winter and spring the freezing and thawing of the water in the subgrade effectively destroy any hard surface that may have been formed at a more favorable season. If efficient drainage were provided this usual "break up" of the roads would not occur.

Good drainage is an absolute necessity in any kind of permanent road improvement. The water from rainfall must not only be gotten off the road surface into the side ditches, but it must be gotten out of the side ditches into the natural watercourses so that it will not penetrate into the subgrade. It is not unusual to see earth roads well crowned and free from ruts, but the side ditches uncared for and the culverts so obstructed that it is impossible for the water to get away except by evaporation or percolation.

Highway superintendents must awaken to their responsibilities and take advantage of every opportunity to secure the best roads possible with the funds at their disposal. Drainage structures such as culverts and bridges must be built in order that vehicles may pass along the roads safely, and it requires only a small additional sum to keep these structures free from obstructions and in condition to permit the water to flow freely.

It is usual to permit the weeds to grow undisturbed along the public highways during the summer months, and by the end of summer the entrances and outlets of culverts and small bridges are hid from view by this luxuriant vegetation. If the weeds, perchance, are cut they are permitted to lie upon the ground until the first freshet washes them against the entrance to the nearest culvert; and the flow of water is almost if not entirely stopped. Drainage structures obstructed in this way are a hindrance rather than a benefit.

The late fall and early winter should be marked by energetic action on the part of road superintendents. All obstructions should be removed from the waterways. All drainage structures should be made effective by the removal of all trash and debris collected at entrances and outlets. These structures should not be permitted to stand throughout the year without serving the purpose for which they were intended. Each structure represents an investment of public funds, and an investment of this sort that does not give a return is a reflection on the judgment or public interest of the official who permits it to exist.

Culverts should be constructed at the low points in the ditches, and the side ditches should be built with a uniform grade leading to them. Care should be exercised in the grading so that no low places are left in which the water may stand.

No obstructions should be permitted in the ditches. It is not unusual to see refuse dumped in the ditches along the sides of the public highways. Frequently one will see a place where the ditch has been shoveled full of earth in order to provide a place for a wagon or other vehicle to cross. Such interferences with proper drainage should not be permitted.

Drainage structures that are worth building are worth building well. It is not sufficient to dig a trench across the roadway, roll a wood box or a section of corrugated pipe into it and cover it over with a thin layer of earth. Good practice in road construction has advanced past that stage. Such methods are a waste of labor and materials. The structure should be located and built with care. It should be at the proper elevation at the inlet so that the water can enter it freely and none be left standing in the side ditch. The outlet should be free from obstruction so that there will be no interference with the flow of water from it. Permanent end walls of masonry should be constructed in all cases. These walls should be long enough and high enough to protect the ends of the pipe, to properly retain the earth fill over the culvert, and to protect the grade from wash. The walls should be of sufficient depth so that freezing of the soil will not disturb them.

In one case a concrete box culvert was built on a state aid road in Illinois. The road was improved by the construction of a brick pavement at a probable cost of $12,000 per mile. If one should ever expect a culvert to be efficient it would be under these conditions. Yet what do we find? The opening is half closed by a ridge of earth left by a road grader used in opening up the side ditch. Weeds have grown up sufficiently to hide the opening almost entirely from view. The bottom of the side ditch is several inches lower than the floor of the culvert, making it impossible for all of the water to be drained from the ditch. A large sum has been spent here to improve the road surface, but nothing has been done to maintain the drainage structures in an efficient manner.

In another case a small corrugated iron pipe culvert has been put in. The waterway is unobstructed and it is doing good service at the present time. However, it is new and there has not been time for the opening to become clogged. A few small pieces of broken tile have been placed about the end of the pipe to protect it. A permanent end wall should have been built. The pipe is covered with only a thin layer of earth, and wagon wheels will soon cut through this covering and strike the metal pipe. Under these conditions the pipe cannot last long. A little additional work would have added greatly to the life of this culvert.

Surely maintenance is a matter that is deserving of more attention at the hands of road officials than has been given to it up to the present time.

*From "Good Roads," of New York.

BRITISH COLUMBIA RAILWAY TRANSFER

The directors and stockholders of the Pacific Great Eastern Railway Company severed their connections with that concern at a formal meeting which took place on April 23rd at the Vancouver headquarters of the company. This meeting has the effect of completely severing the connection that Foley, Welch and Stewart and their assistants had with the Pacific Great Eastern Railway and the Pacific Great Eastern Equipment Company. They still retain an interest in the Pacific Great Eastern Development Company. Under the act which was passed by the legislature the government has two years after the war in which to exercise its option to take over all the assets of the concern, and failing to do so, Foley, Welch and Stewart have five years in which to acquire these assets on payment of $50,000.

TENTATIVE DRAFT OF STANDARD SPECIFICATION FOR CAST IRON PIPE AND SPECIAL CASTINGS

THE Committee on Revision of Standard Specifications for Cast Iron Water Pipes and Special Castings, appointed by the American Waterworks Association, has submitted its report. This committee, appointed in 1911, has for several years co-operated with a similar committee of the New England Waterworks Association

The following is the tentative draft of the new specifications (the changes from existing New England and American specifications are in italics):—

Description of Pipe

SECTION 1. The pipes shall be made with *bell* and spigot *ends or with flange ends* and shall *conform accurately* to the dimensions given in Tables Nos. .... and .... They shall be straight and shall be true circles in section, with their inner and outer surfaces concentric, and shall be of the specified dimensions in outside diameter.

Bell and spigot pipes shall be at least 12 ft. in laying length, exclusive of the bell, and flange pipes shall be at least 12 ft. in length face to face of flanges.

All classes of pipe of each size shall have the same outside diameter. All pipes having the same outside diameter shall have the same inside diameter at both ends. The inside diameter of the lighter pipes of each standard outside diameter shall be gradually increased for a distance of about 6 in. from each end of the pipe barrel, so as to obtain the required standard thickness and weight for each size and class of pipe.

Description of Fittings

SECTION 2. *There shall be two types of standard fittings, known as "Bell Fittings" and "Flange Fittings." Fittings having bell or spigot ends, or both, but no flange end or ends, shall be known as "Bell Fittings." Fittings having one or more flange ends shall be known as "Flange Fittings."*

All fittings shall be made in accordance with the cuts and dimensions given in the tables forming a part of these specifications. They shall be true circles in section with their inner and outer surfaces concentric on both run and outlet, except where intersections prevent. On all fittings the outside diameter of the barrel on each outlet shall be the same as the outside diameter of the pipe of corresponding size.

For pipes from 4 to 20 in. in diameter, inclusive, one class of fittings known as Class D fittings shall be furnished for all classes of pipe. For pipes over 20 in. in diameter, two classes of fittings, known respectively as Class AB and CD fittings, shall be furnished, Class AB fittings for Class A and Class B pipes, and Class CD fittings for Class C and Class D pipes.

Any fittings not shown in the tables hereto attached shall be known as a "Special Fitting."

Variation in Diameter of Bells and Spigots

SECTION 3. Especial care shall be taken to have the *bells* and spigots of the required size. The *bells* and spigots will be tested by circular gauges, and no pipe *or fitting* will be accepted *which, for any cause, does not comply with the specified joint space, except as hereinafter allowed.*

The inside diameters of the bells and the outside diameters of the spigot ends of pipes shall not vary from the standard dimensions by more than 0.06 in. for pipes 16 in. or less in diameter; 0.08 in. for pipes 18, 20 and 24 in. in diameter; 0.10 in. for pipes 30, 36 and 42 in. in diameter; 0.13 in. for pipes 48, 54 and 60 in. in diameter; *and 0.18 in. for pipes 72 and 84 in. in diameter.*

The inside diameters of the bells and the outside diameters of the spigot ends of the fittings shall not vary from the standard dimensions by more than 0.08 in. for fittings 16 in. or less in diameter; 0.10 in. for 18, 20, and 24 in. fittings; 0.13 in. for 30, 36 and 42 in. fittings; 0.16 in. for 48, 54 and 60 in. fittings; and 0.20 in. for 72 and 84 in. fittings.

Variation in Thickness

SECTION 4. For pipes whose standard thickness is less than 1 in. the thickness of metal in the body of the pipe *shall not vary more than* 0.08 in. from the standard thickness, and for pipes whose standard thickness is 1 in. or more, the variation shall not exceed 0.10 in., except that for spaces *the length across which in any direction does not exceed 8 in., a decreased thickness not exceeding 0.02 in. will be permitted, and for spaces the length across which does not exceed 16 in. in any direction, an increased thickness, not exceeding 0.05 in. will be permitted*—both in excess of the allowances above stated.

For fittings, a variation 50% greater than that allowed for pipes shall be permitted.

Allowable Percentage of Variation in Weight

SECTION 5. No pipe shall be accepted, the weight of which shall be less than the standard weight by more than 5 per cent. for pipes 16 in. or less in diameter and 4 per cent. for pipes more than 16 in. in diameter, and no excess above the standard weight of more than the above given percentages for the several sizes shall be paid for. The total weight of pipe to be paid for shall not exceed, for each size and class of pipe received, the sum of the standard weights of the same number of pieces of the given sizes and classes by more than 2 per cent.

No *fitting* shall be accepted, the weight of which shall be less than the standard by more than 10 per cent. for *fittings* 12 in. or less in diameter and 8 per cent. for larger sizes (except that curves and Y-branches may be 12 per cent. below the standard weight); no excess above the standard weight of more than the above given percentages for the several sizes shall be paid for. *The total weight of fittings to be paid for shall not exceed the sum of the standard weights of the same number of pieces of the given sizes and classes by more than 5 per cent.*

Quality of Iron

SECTION 6. All pipes and fittings shall be made of cast iron of good quality and of such character as shall make the metal of the casting strong, tough, and of even grain, and soft enough satisfactorily to admit of drilling and cutting. The metal shall be made without *the admixture of any inferior material,* and shall be remelted in cupola or air furnace.

The contractor shall furnish the engineer with copies of the mill analyses of each heat or run of metal, and shall furnish samples to the engineer for check analyses when required.

The metal for the pipes and fittings shall fulfil the following chemical requirements: Total carbon, 3 to 3.75 per cent.; combined carbon, 0.5 to 0.75; silicon, 1.6 to 2; manganese, 0.35 to 0.55; phosphorus, not to exceed 0.90; sulphur, not to exceed 0.10 per cent.

Tests of Material

Section 7. Specimen bars of the metal used, each being 26 in. long by 2 in. wide and 1 in. thick, shall be made, without charge, as often as the engineer may direct, and in default of definite instructions the contractor shall make and test at least one bar from each heat or run of metal. The bars, when placed flatwise upon supports 24 in. apart and loaded in the centre, shall support a load of 2,000 lbs., and show a deflection of not less than *0.32 in. before breaking, and an increase in deflection of not less than 0.03 in. for each 200 lbs. of ultimate breaking load in excess of 2,000 lbs.*

The contractor shall have the right to make and break three bars from each heat or run of metal, and the test shall be based upon the average results of the three bars. Should the dimensions of the bars differ from those above given, a proper allowance therefor shall be made in the results of the tests.

Casting of Pipe

Section 8. The pipes shall be cast in dry sand moulds in a vertical position. Pipes 16 in. or less in diameter *may* be cast with the *bell* end up or down, unless *otherwise* specified *by the purchaser.* Pipes 18 in. or more in diameter shall be cast with the bell end down.

The pipes shall not be stripped or taken from the pit while showing color of heat, but shall be left in the flasks for a sufficient length of time to prevent contraction by subsequent exposure.

Quality of Castings

Section 9. The pipes and fittings shall be smooth, free from scales, lumps, blisters, sand holes and defects of every nature which, in the opinion of the engineer, unfit them for the use for which they are intended. No plugging or filling will be allowed.

Marking

Section 10. *Each* pipe and *fitting* shall have distinctly cast upon it the initials of the maker's name, a *letter designating the class to which the casting belongs, and figures showing the year in which it was cast. When cast to order, if required by the purchaser, each pipe and fitting 6 in. or more in diameter shall also have cast upon it a serial number, designating the order in point of time in which it was cast, the serial number to be placed below the date, thus:*

1916	1916	1916
1	2	3

etc., and any initials, not exceeding four, *or a symbol,* which may be required.

The letters and figures shall be cast on the outside, and shall *be not* less than 2 in. in length and 1/8 in. in relief for pipes *and fittings 10 in.* in diameter and larger. For smaller sizes of pipe, the letters may be 1 in. in length. The weight, *serial number,* and class letter shall be conspicuously painted in white on the inside of each pipe and *fitting* after the coating has become hard.

Defective Spigot Ends May Be Cut

Section 11. Defective spigot ends on pipes 12 in. or more in diameter may be cut off in a lathe, and half-round wrought-iron or *mild-steel* band, shrunk into a groove, cut at the end of the pipe. Not more than 12 per cent. of the total number of accepted pipes of each size shall be cut and banded, and no pipe shall be banded which is less than 11 ft. in length, exclusive of socket.

Pipes may be cast with shrink-head above spigot bead, and such pipe shall not be considered as cut pipe in determining the percentage above referred to.

In case the length of pipe differs from 12 ft., the standard weight of the pipe given in Table shall be modified in accordance therewith.

Flanges

Section 12. *Flanges shall be cast solid and shall be accurately faced smooth and true. Holes for bolts or studs shall be drilled, and the flanges shall be tapped where required. The contractor shall furnish and deliver all bolts and nuts for bolting on manhole covers. The bolts and nuts shall be of the best-quality wrought iron or mild steel, with good, sound, well-fitting threads, the nuts to be cold punched. The heads and nuts shall be hexagonal and shall be trimmed and chamfered. The heads, nuts and threads shall be of the United States Standard sizes.*

Cleaning and Inspection

Section 13. All pipes and *fittings* shall be thoroughly cleaned and subjected to a careful hammer inspection. No casting shall be coated unless entirely clean and free from rust, and approved in these respects by the *engineer* immediately before being *coated.*

Coating

Section 14. Every pipe and *fitting* shall be coated inside and out with coal-tar pitch varnish. *Each pipe and fitting shall be heated to a uniform temperature of 320 degrees F., in a suitable oven, before it is dipped, and the material in the tank shall also be maintained at this temperature, and each pipe and fitting shall be kept in the bath for at least five minutes, during which time the temperature of all parts of the bath, including the bottom, shall be as specified.*

After removing the pipe from the bath, it shall be suspended or set in a vertical position until the coating has solidified.

The coating shall be of pitch, made from coal tar, distilled until the naphtha is removed, and sufficient oil to make a smooth coating, tough, elastic, strongly adhesive to the metal, tough and tenacious when cold, and not brittle nor with any tendency to scale off. Coating shall not be soft enough to flow when exposed to summer heat, nor brittle enough to crack and scale when exposed to a temperature below freezing.

The pitch shall be straight-run, coal-tar pitch, which shall soften at 60 degrees F., and melt at 100 degrees F., being a grade in which distillate oils, distilled therefrom, shall have a specific gravity of 1.05. The pitch shall not contain less than 10 per cent. nor more than 18 per cent. of free carbon.

Fresh pitch and oil shall be added to the tank when necessary to keep the mixture of the proper consistency. The oil used for this purpose shall consist of heavy, coal-tar oil, with a specific gravity of not less than 1.04 at 60 degrees F., and which shall not lose more than 5 per cent. of oil when distilled up to 400 degrees F.; not more than 40 per cent. of oil when distilled up to 450 degrees F. If the material in the tank thickens or deteriorates when used, the tank shall be emptied of its contents and refilled with fresh material when deemed necessary by the engineer.

Fittings which are too large to be immersed shall be coated with hot varnish by hand, the fittings to be heated as specified above and the coating applied immediately thereafter.

Faces of flanges and finished surfaces shall be coated with a mixture of grease and white lead immediately after they have been faced and drilled.

Any pipe or *fitting* that is to be recoated shall first be thoroughly scraped and cleaned.

Hydrostatic Test

SECTION 15. When the coating has become hard, the pipe shall be subjected to a proof by hydrostatic pressure, and if required by the engineer, they shall also be subjected to a hammer test under this pressure.

The pressures to which the different sizes and classes of pipe shall be subjected are as follows:

Class.	Hydrostatic Pressure Lb. per Sq. In. Diameter Less than 20 in.	Diameter 20 in. and Over.
A	300	150
B	300	200
C	300	250
D	300	300

The full hydrostatic pressure shall be applied to the pipes for one minute on pipes 12 in. and less diameter; for two minutes on 14, 16, 18, 20 and 24 in. pipes; for three minutes on 36 in. pipes; and for five minutes on pipes larger than 36 in. in diameter.

Fittings shall also be subjected to a proof by hydrostatic pressure, provided the same is specified in the contract. If tested, the hydrostatic pressures to which the fittings shall be subjected shall be the same as those to which pipes of the same size and class would be subjected and shall be applied for the same length of time.

Weighing

SECTION 16. The pipes and *fittings* shall be weighed for payment under the supervision of the engineer after *they have been coated.* If desired by the purchaser, the pipes and *fittings* shall be weighed after their delivery. The weight so ascertained shall be used in the final settlement, provided such weighing is done by a legalized weigh master. *The cost of weighing after delivery shall be borne by the purchaser.*

Bids shall be submitted and final settlement made upon the basis of a ton of 2,000 lbs.

Contractor to Furnish Men and Material

SECTION 17. The *contractor* shall provide all tools, testing machines, materials and men necessary for the required testing, inspection and weighing at the foundry of the pipes and *fittings,* and should the purchaser have no inspector at the *foundry,* the contractor shall, if required by the purchaser, furnish a sworn statement that all of the tests have been made as specified, this statement to contain the results of *the chemical and physical tests.*

Power to Inspect

SECTION 18. The engineer shall be at liberty at all times to inspect the material at the foundry and the moulding, casting and coating of the pipes and *fittings.* The forms, sizes, uniformity and conditions of all pipes and *fittings* herein referred to shall be subject to his inspection and approval, and he may reject, without proving, any pipe or *fitting* which is not in conformity with the specifications or drawings furnished.

Inspector to Report

SECTION 19. The inspector at the foundry shall report daily to the contractor all pipes and *fittings rejected,* with the causes for rejection.

Castings to be Delivered Sound and Perfect

SECTION 20. All pipes and *fittings shall* be delivered in all respects sound and conformable to these specifications. The inspection shall not relieve the contractor of any of his obligations in this respect, and defective pipes or *fittings* which may have passed the engineer at the foundry or elsewhere shall be at all times liable to rejection, when discovered, until the final completion and adjustment of the contract, provided, however, that the contractor shall not be held liable for pipes or *fittings* found to be cracked after they have been accepted at the agreed point of delivery. Care shall be taken in handling the pipes *and fittings* not to injure the coating, and no pipes, *fittings* or other material of any kind shall be placed in the pipes or *fittings* during transportation *or at* any time after they have *been coated.*

The contractor shall not be held responsible for any expenses or damages incurred in handling or using the castings after they have been accepted at the agreed point of delivery. Any pipe or fitting that proves defective shall, when requested, be replaced by the contractor, the measure of the damage not to exceed the value of the casting found defective. The contractor shall have the right to call for the defective casting to be returned to him at the agreed point of delivery before any allowance for the same is demanded.

Definition of the Word "Engineer"

SECTION 21. Wherever the word "engineer" is used herein, it shall be understood to mean the engineer or inspector acting for the purchaser, and his properly authorized agents, limited by the particular duties intrusted to them.

ROAD DESIGN A LOCAL PROBLEM*

By Charles H. Moorefield
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MANY factors are to be considered in planning the improvement of almost any public road, let alone a system of roads for an entire community. Almost daily the Office of Public Roads and Rural Engineering is in receipt of the query "What kind of roads are cheapest and best for my community to build?" Replies necessarily must be more or less disappointing because the information in the letters of inquiry seldom is sufficient to warrant the office in offering any very definite advice.

Road design is, in general, a local problem, the proper solution of which involves: (1) The safety, convenience, and comfort of those for whose use the road is intended; (2) the amount of funds available for the improvement; (3) the relative availability and cost of various road-building materials that might prove suitable for constructing a road of the general character desired.

In other words, the aim in planning public road improvements should be (1) to furnish the taxpayers the kind of public road accommodations they need and are able to pay for, and (2) to attain this purpose at the least possible ultimate cost to the public treasury.

In order to accomplish this the person who designs a road must be thoroughly familiar with local conditions, and must possess the judgment necessary to weigh the importance of the various factors that should be considered.

From what has been said it is evident that the most to be hoped from a general discussion of road design is a presentation of facts and suggestions that may serve in a measure to guide the judgment in adapting the design of a particular road to local conditions.

*Abstracted from report to the Department of Agriculture, U.S.A.

THE SINKING AND LINING OF LARGE BORE WELLS FOR PUBLIC WATER SUPPLIES*

By W. H. Maxwell, A.M.I.C.E.
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ECONOMICAL water supplies are frequently obtainable for public purposes by sinking borings in districts where the geological formation is favorable and by these means the writer has recently procured a supplementary supply in his district from two new large-diameter bore wells, which have proved capable of yielding 60,000 gallons per hour.

Water-bearing Strata

This supply is derived from beds known geographically as Ashdown sand rock of the Hastings series, which, at the site of the borings in question, is reached after passing through 185 ft. of Wadhurst clay. The depth of boring into the sand rock is 151 ft., portions of which proved to be well fissured, whilst other parts were found solid and compact.

The superincumbent clay in its natural state is a hard impervious mass, but, after contact with water, becomes softened into a treacherous and uncertain material, requiring immediate lateral support by means of the permanent metal linings of the borings.

The Ashdown sand rock is a fine grained whitish, or pale yellow sandstone, largely impregnated with iron, some of which is dissolved into the water. The layers of this rock are separated by many beds of pale yellow clay. The progress of boring was sometimes slow, owing to the hardness of the rock, and, in the course of the work, the greatest depth of continuous solid rock was 20 feet.

Side-slips and settlements in the Wadhurst clay were frequent during boring operations, and these, at times, caused some anxiety, having regard to the nearness of some heavy engine foundations and three large pumping mains working under a pressure of 200 lbs. to the square inch. These had to be kept in perfect order for the daily supply to the district.

Cast Iron Lining Tubes

The boring and lining operations were carried on under water throughout the work. This in the earlier stages of the work, was derived from points near the surface, and had, therefore, later on, to be completely excluded, being unsuited for purposes of public supply.

The natural water from the Ashdown sand rock is of a corrosive nature, and acts detrimentally upon some classes of metal immersed in the wells for long periods on account of its chemical composition. The action is due to the presence of salts which, although themselves neutral, may act as electrolytes, producing galvanic activity between dissimilar metals, or between dissimilar parts of the same metal.

From previous experience it was proved that the usual mild steel screwed and socketed lining tubes were not sufficiently resistive for the conditions described, the metal being eroded into holes in the course of a few years. After a prolonged investigation with metallurgical tests and laboratory experiments conducted by Mr. Bertram Blount, chemist, etc., of Westminster, it was finally decided to adopt cast iron tubes, 1¼-in. thickness, as the most suitable lining material. Practical experience extending over many years had also shown that cast iron was not perceptibly affected by the water, provided no machined or bright face was exposed to its prolonged action.

The metal used in the lining tubes was required to be of such a composition and texture as would render it highly resistive to attack by the water, and was of a tough, uniform, dense, and close-grained character. Irregularity of composition was avoided as far as possible.

The over-all diameter of the borings through the clay is 39 ins., and the tubes lining same were made from a mixture of strong grey cast iron, sufficiently tough to allow of the castings being readily drilled and tapped with a clean and strong thread. The metal used was not permitted to be from first runnings, but was re-melted in the cupola or air furnace. All sharp angles in the castings

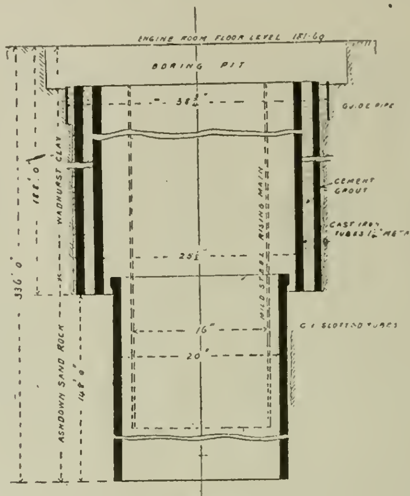

Fig. 1—Section of Bore Wells, Showing Method of Lining, Etc.

were avoided, so as to reduce the liability of cutting through the protective "coatings," subsequently applied.

The tubes were cast vertically in 12-ft. lengths, in dry sand moulds, and in accurately faced and truly jointed boxes, without the use of core nails, chaplets, thickness pieces, or any similar substitutes. An ample "head" of metal was insisted upon to ensure thorough soundness throughout, the head being afterwards cut off in a lathe. The whole column of tubes lining the borings, weighing about 40 tons in the case of the largest diameter, had to be suspended in the boring, jointed at the ground surface, and lowered gradually as the work of sinking proceeded. After lowering a sufficient depth, additional tubes were added to the top of the hanging column, so that it was essential the machined ends and joining-up sleeves should fit accurately and without difficulty or delay.

During manufacture, the tubes were regularly inspected at the foundry from time to time as made, and were tested for quality of metal, and carefully examined to see that they were truly cast, straight, perfectly cylindrical, and of uniform thickness. The ends of the tubes were afterwards accurately machined down circumferentially to templates in a lathe, and fitted with mild steel sleeves or sockets for the purpose of forming the joints between the various lengths of tubes.

The linings through the clay (Fig. 1) consisted of two rings of cast iron. Through the Ashdown sand rock one

*"Water and Water Engineering," London. Eng.

ring of cast iron perforated tubes was used, as this rock and the intermediate clay beds were not sufficiently stable to stand permanently without lining.

Portland Cement Grouting

The space, 2⅛ ins. in width, between the two concentric rings of cast iron passing through the clay was filled with Portland cement grout, in order that, should the inner cast iron ring deteriorate after many years, there would remain a continuous ring of cement to protect the outer cast iron lining.

Portland cement grout was also placed at the back of the outer cast iron tubes to fill up the space and cavities formed by slips in the clay between this lining and the natural ground, thereby giving additional protection, and also excluding infiltration of impure surface water. The grout was mixed to a thick creamy consistency, and all passed through a fine wire netting sieve of about ⅛-in. mesh, in order to remove all lumpy or unmixed particles. In the case of the first borehole, the cement grout was simply poured into the tops of the annular spaces to be filled, and the water thus forced out. The grouting was continued in this way until all spaces were full, and the thick grout appeared at the tops of the tubes.

A different method of grouting was adopted in the case of the second boring, in order to check the quantity of cement used, and also to confirm the assumption that the spaces had been solidly filled. The dimensions of both borings are exactly similar, so that the quantities of grout used should also be identical. In this case a 1-in. diameter galvanized iron pipe was passed down the annular space for the purpose of conveying the grout down to the bottom of the cavity to be filled. This pipe was supplied with grout from a Greathead grouting machine, and forced down by compressed air. After discharging the contents of the grouting cylinder the 1-in. pipe was raised in the annular space by a previously determined amount, so as just to reach the surface of the last deposit of grout.

This process was continued until the space was quite full. A comparison of the weight of cement used in this case with that used in the first-named boring showed it to be identical in weight within a very trifling amount, from which it was concluded that the annular spaces throughout their depth had both been solidly filled. All grouting operations once started were continued day and night, if necessary, without intermission.

Manufacture and Handling of the Lining Tubes

The whole of the tubes and their accompanying sockets were carefully fitted and marked at the maker's works before despatch, so as to ensure accuracy and ease of fitting on the site of the bore wells. The tubes were numbered consecutively throughout for purposes of record and for convenient handling. At the site of the bore wells, the tubes were stored in the order they ultimately occupied in the wells, in order to minimize labor of handling and probable consequent damage to their surfaces and coatings.

Every precaution was taken to avoid breaking through the foundry skin of the metal, and any small projections or ridges on the surfaces of the tubes were passed undisturbed, without fettling or dressing off, so as not to expose the bright metal to the action of the water. With the same object in view, the machined ends of the tubes and faces of sockets were thoroughly well covered with a hot bituminous coating during the process of jointing up the tubes.

All tubes were tested at the foundry before "coating," in the presence of the engineers' representative, by hydraulic pressure to 200 lbs. to the square inch. This pressure was maintained for a period of from five to ten minutes, and during the test the tubes were smartly struck all over with a 2½-lb. hammer. After satisfactorily passing this test, each tube was stamped with the engineers' private mark.

The specification required the manufacturer to furnish from each running two test pieces of the metal to be

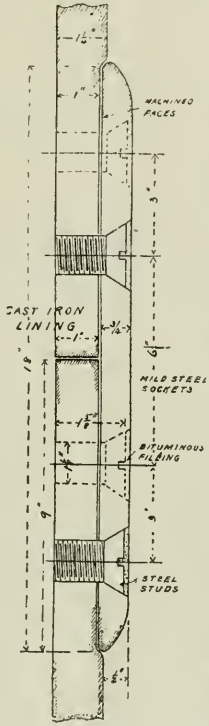

Fig. 2—Detail of Joint in Lining Tubes and Sleeves

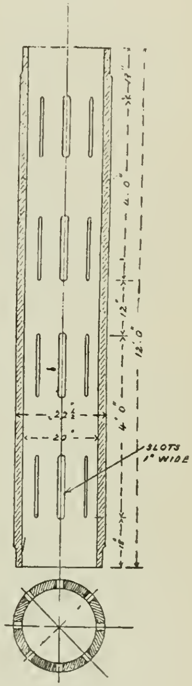

Fig. 3—Cast Iron Slotted Tubes

actually used in casting the tubes, and the deflection test was specified as follows: "A bar, 1 in. wide, 2 ins. deep, and 3 ft. 6 ins. long, when supported on edge on bearings 3 ft. apart, shall sustain a load of 30 cwt., applied at the centre, with a deflection of not less than ⅜ in. The bar shall be tested to destruction." All tubes rejected by the engineer were required to be broken up in the presence of his representative.

Method of Jointing the Cast Iron Tubes

The largest size of cast iron tube was 32¼ ins. inside diameter by 12 ft. long, and the metal was 1¼ ins. in thickness. Each pipe of this size weighed approximately 2¼ tons. The ends of the 12-ft. tubes were machined down, at the foundry, for a length of 9 ins. from 1¼ ins. in thickness to 1 in. thick (Fig. 2) so as to minimize the projection of the mild steel sleeves, and to reduce friction against the sides of the borings during the lowering of the tubes into position. The butt ends of the tubes were also machined true and square to the centre line, and the joints between the different lengths were made by means of mild

steel sleeves 18 ins. long by ¾ in. thickness of metal, tapered at the top and bottom ends to minimize surface friction. The sleeves and machined ends made a first-class close-fitting joint, which was secured by mild steel studs 1⅛ ins. in diameter, spaced according to the load to be carried. The number of the studs varied according to the weight of the tubes to be suspended. The studs and all surfaces of sleeves and tubes were covered with hot bituminous material whilst being put together. The joints in the 12-ft. tubes for the inner and outer linings were staggered by starting with a 6-ft. length of outside lining and a 12-ft. length of inside lining. The tubes for the inner cast iron lining had four lugs cast on the outer circumference near the bottom of each pipe to keep the linings concentric. The double cast iron lining was sunk 3 ft. into the rock to a total depth of 188 ft., so as to overlap the 20-in. perforated tubes, as shown in the first illustration.

Mild Steel Guide Tubes at Top of Borings

At the tops of the borings guide tubes were fixed for a depth of 30 ft. These consisted of lap-welded mild steel pipes, 38¾ ins. internal diameter, of metal ¼ in. thick, formed in two 15-ft. lengths, and jointed into one pipe 30 ft. long by means of external welded circumferential butt straps, single riveted on.

Slotted Tubes in Ashdown Sand Rock

The perforated or slotted tubes lining the Ashdown sand rock, which forms the water-bearing strata, are of the same thickness of metal and are jointed similarly to the solid tubes already referred to. The slotted tubes are shown in Fig. 3. Wherever the 1-in. slots or perforations come opposite soft clay beds occurring in the Ashdown sand, the slots were filled with Portland cement before placing the pipes in position, in order to shut out, as far as possible, any friable material likely to fall off the sides of the borings into the insides of the tubes. Careful measurements were taken during the sinking of the bore wells by means of the boring rods of the positions and depths of the strata bored through.

Bituminous Coatings Used for Protective Purposes

The cast iron tubes, immediately on being turned out from the foundry, were subjected to an hydraulic pressure test. Those proving satisfactory were at once machined at the ends as explained above, and afterwards "coated" as soon as possible to avoid rust.

Having first been cleaned free from mould, sand, etc., the tubes were then fully immersed in a bath of clean hot water at full boiling temperature, to remove carbon, dirt, or other foreign substances, and were not removed from the bath till they had acquired the temperature of the water. After removal from this hot water bath, the tubes were separately wholly immersed vertically in a hot solution of the bituminous coating prepared according to the Dr. Angus Smith process at a temperature of from 300 to 350 degs. Fahr. The pipes remained in this solution for some minutes, and were then gradually withdrawn and allowed to drain off by suspending them in a vertical position. The coating fumed freely, and set hard within an hour. In order to avoid pin holes, and to render the coatings more uniform, the tubes were twice dipped as above described. The bituminous mixture consisted of refined coal tar, pitch, linseed oil, and resin, heated in a suitable furnace, and the whole process resulted in a good, firm, durable coat upon all castings used. Similar bituminous coatings were applied hot at the site of the works to the joints, whilst putting the tubes together ready for lowering into the borings.

Previous to despatch by rail, the tubes were all packed with soft material, so as to prevent damage to the coatings in transit. All bright machined parts were also coated, but this coating had to be cleaned off immediately before joining up the tubes, in order to permit of the spigot ends entering the mild steel sleeves. A fresh hot coating was then applied, and the tube slipped home into its final position in the sleeve. The studs, after immersion in the bituminous composition, were then inserted.

Sinking of Lining Tubes After Placing in Borings

A short time after the 20-in. perforated tubes took their full bearing upon the bottoms of the borings, these tubes, owing to their considerable weight, and to the gradual softening of the strata due to the access of water thereto, commenced sinking. This trouble, if not arrested, would soon have had the effect of losing the necessary lap provided at the top of the 20-in. perforated tubes. During boring operations it was found that the principal water-bearing fissures occurred some distance up from the bottoms of the borings, and, in view of this, in order to arrest the further settlement of the 20-in. tubes, a Portland cement grout plug, about 7 ft. in length, was placed at the bottoms of the two bores at a depth of 336 ft. from the surface. When these plugs had become properly set, the sinkage of the cast iron linings completely stopped. In the event of it being desired at any future date to sink the borings deeper, these cement plugs could readily be bored through with a smaller diameter hole.

REPORT ON LIQUID CHLORINE

A. F. Macallum, commissioner of works of Ottawa, Ont., was recently requested by the Board of Control of that city to report on the cost of installing apparatus to sterilize the city's water supply with liquid chlorine instead of the chloramine now used in Ottawa. Mr. Macallum reported as follows:—

"With reference to the use of liquid chlorine in connection with the treatment of the city's water supply, I beg to say that at the present prices of ammonia bleach and liquid chlorine, the bleaching method is the cheaper by $2,000 per year. This is on the assumption that we are paying the present price of 10 cents per pound for ammonia and 3 cents per pound for bleach. The present supplies will last about four months.

"As the price of ammonia has advanced 100% in Canada during the last year and 300% in the United States, it is quite probable that as ammonia is being largely used for war purposes, the price will stay high for some time. On the other hand, liquid chlorine has a very high price as it is being used to ship to Europe for war purposes, and this, together with the ever-increasing demand for water treatment, has kept the price up to an abnormal figure, but as the price is tending downwards, it is possible at the end of three or four months that the cost of liquid chlorine treatment will be equal to chloramine.

"However, until such time as it is shown that it will be cheaper to operate by liquid chlorine, including the cost of installing an apparatus sufficiently large for the purpose, it will be cheaper to operate as we are at present

(Concluded on page 426)

USE OF BLAST FURNACE SLAG IN REINFORCED CONCRETE WORK, TAKING INTO ESPECIAL CONSIDERATION ITS PROBABLE DURATION*

By W. S. Lacher

SLAGS are defined in "Cement Limes and Plasters" by Eckel as "fusible silicates formed during the smelting or refining of metals by combination of the fluxing materials with the gangue of the ore. The composition of the slag, therefore, will be determined by the composition and relative proportions of the fluxes and the gangue." The slags of the iron and steel industry comprise those formed by the reduction of iron in a blast furnace and those resulting from the manufacture of steel. They are also sometimes differentiated to distinguish between those derived from the manufacture of Bessemer iron known as acid slags, and those resulting in the reduction of non-Bessemer ores known as basic slags.

The physical properties of slags are determined very largely by the methods used in cooling or disposal. This permits of division into three general classes: air-cooled bank slag, granulated slag and machine slag. Granulated slag, the result of quenching with water, is a very light material, somewhat resembling sand, and has had but limited application as a concrete aggregate. Machine slag is not produced in sufficient quantities to be generally available.

The most common form of slag is that produced by dumping the molten slag from ladles into large spoil banks where it cools slowly by exposure to the air while being warmed by contact with preceding deposits and forms into a stone-like substance. It is removed for commercial utilization by a steam shovel, and when used like broken stone it is passed through a crusher and may be obtained in the gradations of size ordinarily available in stone.

From the above it is clear that the term "slag" includes materials of varying origin and widely differing physical properties. A deposit of this material may contain only the relatively pure by-product of a single process, such as the reduction of iron in a blast furnace, or it may be composed of the conglomeration of materials from many processes, including the miscellaneous refuse of steel manufacture, obviously a mass of too indefinite a composition to be a trustworthy structural material. Consequently this discussion is limited to a slag having a sufficient market value as a by-product to justify production practices that will insure a uniform product free from foreign matter.

A further limitation is in the use of slag only as the coarse aggregate of the concrete, the fine aggregate being a natural sand conforming to the usual requirements for a fine aggregate. Tests of slag concretes in which the fine aggregate was a granulated or a finely crushed slag indicates its general inferiority as compared to sand of good quality.

Properties of Air-Cooled Blast Furnace Slag

Air-cooled slag has a generally dull gray color with varying degrees of porosity from that of pumice stone on one hand to a dense limestone on the other. It consists essentially of silica, alumina, iron oxide, and lime with or without magnesia. Sulphur is usually present in small quantities. The range of composition given by various authorities is as follows:—

Silica	26.88	to	38.0	per cent.
Alumina	10.0	to	28.0	per cent.
Iron	0.44	to	0.75	per cent.
Lime	29.0	to	50.0	per cent.
Magnesia	1.0	to	18.50	per cent.
Sulphur	trace	to	4.90	per cent.

In a report prepared by Sanford E. Thompson presented in abstract before the American Concrete Institute in February, 1917, he gives the range of usual composition as follows:—

Silica	32.0	to	36.0	per cent.
Alumina and iron	11.0	to	15.0	per cent.
Lime	40.0	to	48.0	per cent.
Magnesia	1.0	to	7.0	per cent.
Sulphur	1.1	to	1.7	per cent.

He differentiates between magnesian slags in which the magnesia content is above 4 per cent. and limestone slags in which magnesia is present to less than 2 per cent.

Slag is usually appreciably lighter than stone. Specific gravity is not a reliable index on account of its porous nature. The weight per cubic foot of crushed slag varies from nearly 100 lbs. to less than 50 lbs. The concrete made with it also weighs less than stone or gravel concrete but usually not less than 135 lbs. per cubic foot.

Use

The use of slag as an aggregate in concrete covers a period of 20 years or more but it is only within recent years that it has had extended use particularly in reinforced concrete. Beginning with its utilization for the concrete structures of the steel companies the greatest development has been in the communities tributary to the steel mills. Large quantities of slag are used in building operation, particularly in Birmingham, Cleveland and Youngstown, Ohio. The use of slag in concrete is sanctioned by the building ordinances of Detroit, Cleveland, Chicago, Philadelphia and Youngstown. Probably the most general use has been at Cleveland, where a large number of reinforced concrete buildings have been constructed with slag as a coarse aggregate. Specific examples of concrete structures in which slag is used include the grade separation structures of the Seaboard Air Line at Birmingham involving 11,000 cu. yds., the Rocky River Bridge at Rocky River, Ohio, subway structures of the Philadelphia Rapid Transit Company and the North Howard Street Bridge at Akron, Ohio. The last is an arch bridge nearly 800 ft. long with a roadway 190 ft. above the bed stream and required the use of 5,000 cu. yds. of concrete.

Strength

Numerous tests have been made of slag concrete which show conclusively that a properly selected slag when used as a coarse aggregate with a good quality of sand as the fine aggregate will produce a strong concrete.

These tests include the following:—

Tests made by Sanford E. Thompson in connection with his investigation and reported before the American Concrete Institute in February, 1917.

Tests by Robert W. Hunt Company in September and November, 1908.

Tests at Cornell University reported in the Cornell Civil Engineer in 1913.

Tests at Columbia University, Department of Civil Engineering, January, 1914.

Tests by Carnegie Steel Company in 1911.

*Abstracted from report by Committee on Masonry, appointed by the American Railway Engineering Association.

Tests reported by W. A. Aiken, Proceedings of American Society for Testing Materials, 1914.

Five-year tests by the Pittsburgh Testing Laboratories, now in progress.

These and other tests brought to notice in recent years go to show that slag concretes are as strong as stone or gravel concretes containing the same quantity of cement, provided a properly selected material is used. The strength bears little relation to the weight of the slag used, the porous varieties producing concretes of fully as great strength as the dense materials for tests at 28 days. For greater ages the concretes made of denser slags show a greater increase in strength. Owing to the fact that slag is generally more porous than stone it is necessary to exercise care in proportioning to provide sufficient mortar to fill the voids in the particles as well as between them.

Soundness

A more important question is that of the soundness of slag concrete. This question is raised by the fact that some slags slake or disintegrate upon exposure to the air and are entirely unsuitable for use as aggregate. It is common practice to allow the slag to weather for a number of months before removing from the bank. This results in a hardening or toughening of the stable slags and permits the detection of those that disintegrate upon exposure to the atmosphere. A considerable difference of opinion and practice exists as to this seasoning, but good practice would seem to demand a period in the bank of six months to a year. However, it is a fact that some slags are used after only a few weeks' exposure with apparently satisfactory results.

The most discussed point in the use of slag as an aggregate in concrete arises from the presence of sulphur. It is contended that a lack of stability of the compounds of this element occurring would result in the eventual disintegration of the concrete and also that its presence would lead to the formation of sulphuric acid which would result in the corrosion of embedded steel. Sulphur usually occurs as a sulphide of calcium, a form in which it is inactive, but in the presence of water it is contended that sulphuric acid would result. On the other hand, slag concrete has been used extensively in foundation work and numerous examples are cited of anchor bolts and other embedded pieces of iron and steel which have been in close contact with slag concrete containing sulphur for many years without any sign of injury.

The following quotation is taken from the report by Sanford E. Thompson :—

On permanence: "As a result of a careful examination of various structures made with slag concrete and interviews with users of slag concrete, I find no evidence of disintegration where Portland cement was used. In certain cases with Puzzolan or slag cement, the concrete is not in first-class condition but this is to be expected with any Puzzolan cement concrete laid in air."

From "Summary": "No authentic cases of deterioration of slag concrete made of Portland cement or of rusting of steel embedded in such concrete have been discovered."

Slag in Railway Structures

With a view to securing some data on experience with slag in railway structures inquiry was made among railway engineers who have used slag in concrete, but owing to the limited application of this material to railroad structures as compared to office and industrial buildings, only a few replies containing information on the subject were obtained. A few of these replies are given below :—

New York Central Railroad, Lines West: "We are now building the Himrod Avenue viaduct over our tracks at Youngstown. The structure is a steel affair with the lower parts completely enclosed in concrete. The Youngstown district is a bad one for obtaining first-class material for concrete. The sand is rather poor, and good first-class stone is not available. Some of the sand and gravel is obtained from the Ohio River, which is dirty and full of coal.

"There is hence every inducement to use slag on account of its cleanliness, uniformity of gradation, and comparatively low cost. The freight situation in this territory is congested, and it is hard to obtain other material on this account.

"Blast furnace slag has been used for a number of years in a small way. We have examined retaining walls that were built of slag at least eight years ago, and have found them in excellent condition. The Lorain Steel Company, at Lorain, Ohio, has used this material quite extensively throughout its plant. At Warren, Ohio, a city reinforced concrete arch was built over the river, about two years ago. This structure seems to be in excellent shape.

"In view of the circumstances, we thought we were warranted in venturing somewhat into a new field. The viaduct proper is now about completed, and the concrete seems to be first-class throughout."—B. R. Leffler, engineer of bridges.

Erie Railroad: "Concerning the behavior of blast furnace slag as an aggregate in plain and reinforced concrete, I attach herewith for your information, a report on the subject from our inspecting engineer, L. W. Walter, who is also in charge of our cement laboratory at Jersey City."—R. S. Parsons, assistant to the president and general manager.

"Slag was used in several structures on the Erie Railroad in the years 1905, 1906 and 1907, and results compare favorably with structures built of other materials during the same period. We have more recently used slag in a few structures where its use has been of economic advantage. Such slag as we are now using in concrete work undergoes our inspection with a view of securing as dense a material as is available.

"I will offer as my opinion that there is room for slag producers to improve the quality of their average shipment by selecting and grading their material with a view of increasing the weight per unit of volume. We desire slag which will weigh 2,000 lbs. per yard, but are seldom able to secure slag weighing over 1,900 lbs. per yard.

"Our experience with slag used on the Erie railroad has been limited to plain concrete, but from observation elsewhere I have formed the opinion that slag in concrete does not cause corrosion of the metal reinforcement."—L. W. Walter, inspecting engineer.

Southern Railway System, Lines West, Southern District: "I beg to advise that we have used it in the construction of depot platform curbings and sidewalks, but to no great extent. The work in some instances stands up very well, but in others, where it receives considerable abuse, it fails under the service."—R. D. Tobien, engineer maintenance.

Seaboard Air Line Railway Company: "Yours of August 29th in regard to use of blast furnace slag in retaining walls of this road at Birmingham.

"The work has been entirely satisfactory to date, and beyond a few surface cracks or crazing, there are no signs of disintegration of any portion of the work."—W. D. Faucette, chief engineer.

AMERICAN WATER WORKS CONVENTION

THE 38th annual convention of the American Water Works Association will be held May 13th-17th inclusive at St. Louis, Mo. Convention headquarters will be at the Planters Hotel.

Monday, May 13th, will be registration and get-together day. On the evening of that day Hon. H. W. Keil, mayor of St. Louis, will welcome the delegates, after which a reception and dance will be tendered to the visitors by the local entertainment committee.

Tuesday, May 14th—Forenoon Session

President's address. "Emergency Construction Work Due to War Conditions," illustrated lecture by George W. Fuller. Reports of committees.

Afternoon

Golf tournament under the auspices of the Permanent Golf Committee of the Water Works Manufacturers' Association and the American Water Works Association.

Evening Session

"Management of Public Utilities in Cantonments," by Major P. Junkersfeld; "The Artesian Water Supply of Savannah, Georgia," by E. R. Conant; "Design of a Tilting Dam and Its Relation to Back Water on the Gunpowder River," by V. B. Siems; "Water Treatment Conditions at Council Grove, Kansas," by Louis L. Tribus.

Wednesday, May 15th—Forenoon Session

Four papers on special features of St. Louis waterworks: "Some Phases of Distribution Work," by W. A. Foley; "The Double Forty-eight-inch Manifold at Bissell's Point," by C. M. Daily; "The New 110-Million-Gallon Pump at Chain of Rocks," by L. A. Day; "Some Aspects of Chemical Treatment at St. Louis Waterworks," by A. V. Graf. Election of nominating committee and selection of place for holding the 1919 convention.

Afternoon

Boat trip on Mississippi River, starting at 12.30 p.m. sharp. Luncheon to be served on the boat. Trip to be made to the mouth of the Missouri River, stopping at St. Louis waterworks on return, arriving in city at 5 p.m. Trip by courtesy of local entertainment committee.

Evening Session

"Literature of Field Water Supply," by Jack J Hinman, Jr.; "The Practicability of Adopting Standards of Quality for Water Supplies," by Robert B. Morse and Abel Wolman; "Preliminary Analysis of the Degree and Nature of Bacterial Removal in Filter Plants," by Abel Wolman.

Thursday, May 16th—Forenoon Session

Experience papers and general discussion on frozen service pipes, water mains and fire hydrants, and new maxima in water consumption based upon experience of the winter of 1917-1918. A number of short experience papers on these subjects will be presented. This will be "Superintendents' Day."

Afternoon Session

Discussion of office records, covering distribution mains, gate valves, service pipes, pipe laying, etc. Short papers, illustrated by lantern slides, will be read.

Evening Session

"Loss of Head in Service Cocks and Service Pipes," by B. J. Bleisteine; "Lead Pipe Couplings," by J. A. Jensen. Discussion of resolution on effect of war time conditions on waterworks management, to be followed by an informal dance at the Planters Hotel at 9.30. Courtesy of the Water Works Manufacturers' Association.

Friday, May 17th—Forenoon Session

Reports of special committees as follows: Depreciation, John W. Alvord, chairman; Revision of Standard Specifications for Cast Iron Pipe and Specials, John H. Gregory, chairman; Private Fire Protection Services, Nicholas S. Hill, Jr., chairman; Official Standards of Water Analysis, William J. Orchard, chairman; Mechanical Analysis of Sand, Phillip Burgess, chairman; Standard Specifications for Wrought Iron Pipe, A. A. Reimer, chairman; Classification of Technical Literature, Nicholas S. Hill, Jr., chairman; City Planning, Ernest P. Goodrich, chairman.

ENGINEERS WANTED OVERSEAS

A. W. SMITH, secretary of the Manitoba Branch, Canadian Society of Civil Engineers, has received the following letter from Capt. J. D. Ruttan, recruiting officer, No. 10 F.R.C. and Engineers' Depot, Winnipeg:—

"With reference to your request for information desired by members of your society re appointments in the Canadian Engineers, I am to advise as follows:

"Engineer officers have been requested for overseas service, possessing the following qualifications:

"Graduates of recognized universities in civil, mining, mechanical or architectural engineering,—or, if not graduates, to have had several years' experience as such. They must be medically fit, that is in category A-2, and should be between the ages of 23 and 35 years inclusive; with the exception, however, of especially desirable and experienced engineers over 35 for whom special headquarters authority may be obtained as special cases.

"These officers are appointed to the Engineer Training Depot, St. Johns, P.Q., for a period of three months' training, if possible in Canada. They are taken on the strength of the Canadian Expeditionary force with the rank of lieutenant immediately upon reporting to the depot, and are granted C.E.F. rates of pay and allowances, *viz.*, $2.60 per diem pay and, if not using government quarters and drawing government rations, they are allowed $1.70 per day subsistence, with the usual $30 per month separation allowance if married or the sole support of a widowed mother.

"Officers for the Canadian Railway Troops must have had a wide experience in the actual construction of railways, and are attached to the Engineer Training depot and qualified in infantry only, the course taking from four to six weeks. They are then transferred to the Railway Construction Depot, Hamilton, Ont., to be sent overseas with drafts from that depot.

"All officers supply their own equipment and kit, but are allowed $250 towards this, $100 payable after three months' service in Canada, or if sent overseas before the three months are up, $150 before sailing, and $100 in England."

The Vancouver city council conceded practically all the demands made by its employes, who went on strike last Saturday noon. The men resumed work Sunday morning upon the increases being granted.

The Toronto and York Highway Commission has been incorporated by the Ontario Legislature under the name, "The Toronto and York Roads Commission," reviving the name by which the toll roads of 1834 were designated in the counties of Ontario, York and Peel.

STRESS MEASUREMENTS ON THE HELL GATE ARCH BRIDGE

UNDER the above title, a valuable paper was recently presented to the American Society of Civil Engineers by D. P. Steinman. The secretary of the society has received the following written discussion on Mr. Steinman's paper:—

F. E. Turneaure, M.Am.Soc.C.E., Madison, Wis.—The measurements on the Hell Gate Bridge are of great value, not only in connection with the determination of stresses in that structure, but also as an important contribution to our knowledge of the amount of secondary stress actually existing in structures. The writer does not believe that it will ever be necessary or desirable to calculate secondary stresses in the ordinary practice of bridge design; but he does believe that their consideration, both theoretically and experimentally, in such unusual structures as the one under consideration, is of very great importance. The more accurate our information may be concerning the various kinds of stresses which exist in a structure, the more safely and economically can such a structure be designed; and, although the extra margin of safety required to take care of uncalculated and indeterminate stresses may not be a very serious matter in structures of ordinary size, it becomes of extreme importance in those of very large size. Both safety and economy demand that as complete knowledge as possible should be obtained concerning all the elements involved. Secondary stress is one of those elements; and, although ordinarily not as large as the primary stress, and not as readily and accurately determined, it is, in many cases, quite comparable in amount, so that it cannot be ignored without making a very large allowance in the margin of safety.

Although the measurements made by Mr. Steinman show a very considerable discrepancy between the calculated and observed values, yet, taking everything into consideration, they constitute a very satisfactory experimental check of calculated results. Nor is it surprising that a very considerable amount of the secondary stress, as measured, was found to be caused by other factors than the bending of the members in the plane of the truss, which is that part of the secondary stress subject to calculation. In tests made by the writer, the same result was obtained in many cases, but where conditions were perfectly symmetrical, the experimental and calculated results agreed very well.

It does not seem to the writer that it is quite safe to draw conclusions relative to secondary stresses in ordinary trusses from the results on the Hell Gate Arch. It is apparent that the arch as designed is in a very favorable condition relative to secondary stresses when under either full dead or full live load. Under such load the main arch rib or lower chord receives its maximum stress, and, therefore, the significant secondary stresses in this member will be those occurring for this condition of loading; but, when the structure is thus loaded, the upper as well as the lower chord is in compression, and the web members are not very highly stressed. This condition results in comparatively low secondary stresses in the chords, much lower relatively than those which occur in an ordinary truss in which the lower chord is in tension and the upper chord is in compression. In the latter case there will evidently be greater distortion of joints than where the chords are subjected to the same kind of stress. As an illustration of a most favorable condition, consider the legs of an elevated water tank. If these are made straight and are centrally loaded at each end, there will be practically no secondary stress except for wind pressure. It would appear, therefore, that the secondary stress to be anticipated in the main chord of the arch would be relatively small, as results of measurement as well as calculations show to be the fact. Calculations also show that, for a live load covering a half span, the secondary stresses reach fairly large values, but these are of no particular significance for the main chord, as the primary stresses for this condition are small. It will be noted that the calculated secondary stresses for this condition of loading reach a value as high as 2,000 lbs. per square inch, which is an indication of what may readily occur in other types of structures where the maximum primary stress occurs at the same time.

It seems, therefore, that no general conclusions can be drawn from these calculations and measurements which can be safely applied to other types. It probably was not Mr. Steinman's intention to suggest that such application could be made, but one of his statements might possibly be interpreted in this direction. His suggested figure of 25% + 4,000 would probably cover most cases of well-designed structures, but the writer would hardly agree with his suggestion that a proper way to treat the matter would be to deduct this from the minimum elastic limit of the material and then use the remainder as a safe working stress for bridge members. There are other things besides secondary stresses which need to be considered in determining the working stresses, and care should be taken to make one step at a time. If it is found that the secondary stresses in any particular structure can be represented safely by a particular percentage of the primary stresses or a percentage plus a constant, then we have arrived at a fair value of the maximum fibre stress, and are much better prepared to discuss the subject of working stresses than if no estimate of the secondary stresses had been made.

It is evident that secondary stresses are much more serious with respect to compression members than tension members, and the precautions taken in the construction of the Hell Gate Bridge to secure fairly concentric loading of segments should be effective in preventing any very extreme secondary stress. Assuming the pressures along the line of contact of the webs (one-third of their width) to vary as much as from zero at one edge to a maximum at the other, the greatest secondary stress which could be produced under such conditions would be approximately 35 per cent. It was to be expected that the actual stresses would be much less than this.

The great care taken in the design and erection of the Hell Gate Arch and the special precautions observed in other large structures of recent design show the increasing appreciation of the importance of scientific methods of design and accurate fabrication of important structures. Where such conditions prevail, the objection to the use of statically indeterminate structures, which has been so general in the past, loses its force, and there would seem to be no reason for excluding such forms of structure where, for other reasons, they are desirable. These are often called indeterminate structures, but such is not the case. They are simply statically indeterminate, and the calculation of the stresses requires a little more work than for structures that are statically determinate. The results of calculation, also, are not quite so accurate, as they are affected somewhat by temperature variations and inaccuracy of fabrication; but they have exactly the same degree of accuracy as the calculations of deflections of statically determinate structures, and it is well known that deflection calculations are very reliable. The same comments hold true, to a large extent, with reference to secondary stress, and such stresses are just as much a real

part of the total stress which may prevail in any fibre of a member as the primary stress; and they are just as certain to exist as it is certain that the structure will deflect under load. The accuracy of their determination, however, is not so great as that of the primary stresses, on account of the indeterminate effect of temperature variations and of joint plates, rivets, and other details.

The very excellent and painstaking work represented by this paper should be an example of what can be done in the scientific treatment of important structures, and the value of the results secured should serve as a strong incentive to other engineers to conduct similar investigations.

Henry S. Jacoby, Assoc.Am.Soc.C.E., Ithaca, N.Y.—By having stress measurements made on the Hell Gate Arch Bridge during its erection, an important service has been rendered to the engineering profession. The design of bridges, as well as other structures, cannot be carried out with the highest regard to both security and economy without the aid of continuous scientific investigation. When observations are made on an actual structure, especially one in which the members are so large and where the resources of construction in equipment and workmanship are taxed to a much higher degree than usual, the results are of far greater value than laboratory experiments could possibly give.

The chief engineer, Mr. Lindenthal, therefore merits the appreciation of every engineer who is actively interested in the progress of bridge design and construction, for deciding to take advantage of this unique opportunity. If a larger number of engineers in charge of construction were willing to combine a relatively small amount of scientific research with important works in construction, the rate of engineering progress would be materially increased. The value of the results thus secured, under wise direction, may be far greater than the extra financial outlay involved. The author deserves credit for the systematic form in which the paper is presented. It is gratifying to learn that the actual secondary stresses were found to be lower than the computed values.

As a part of this discussion it may be interesting to present the computed secondary stresses in a two-hinged, spandrel-braced arch with cantilever arms. The design of the arch and of the adjacent suspended spans, a critical

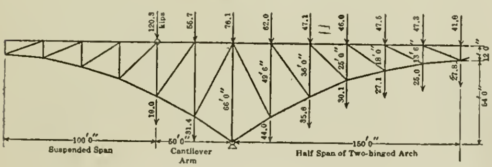

Fig. 1.—General Dimensions and Dead Panel Loads

discussion of various methods for determining the primary stresses, and the computation of the secondary stresses, were presented to the Faculty of the Graduate School of Cornell University as a thesis for the degree of M.C.E. by Mr. Thomson Mao in June, 1917.

The general dimensions of the trusses, and the dead panel loads, expressed in kips or units of 1,000 lbs., are shown in Fig. 1, and the notation used for the truss members, the live panel loads, and the joints, is shown in Fig. 2. The live panel loads on the right half of the arch are 7, 8, 9, 10, 11 and 12, while those on the right cantilever are 11′ and 10′. Various properties of the truss members required in the computations are given in Table 1. The revised primary stresses in the members of the half arch and a cantilever arm are given in Table 2. The live panel load per truss is 141.6 kips, the panel load 2′ at the end of the cantilever being 445.8 kips, of which 375.0 kips equals the reaction of the suspended span. The impact was computed by the formula $I = \dfrac{300\ S}{(300 + L)}$, in which I is the impact stress, S is the live-load stress, and L is the loaded length producing the greatest live-load stress. The stresses due to temperature were computed for a range of ± 75° from the mean. The wind stresses were

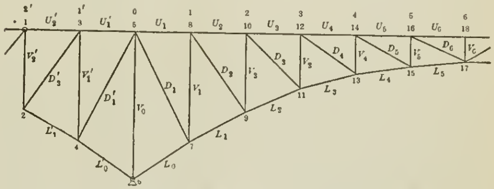

Fig. 2.—Notation of Members, Panel Loads and Joints

found to be less than 25% of the other stresses, except in the two upper chord members of the cantilever arm. These two members have a large excess of section, as the section of the upper chord is the same for five panels.

The secondary stresses were determined by what is known as Mohr's method, in which displacement diagrams are constructed to find the change in slope of truss members. In applying the method, it was planned to find the primary stresses in all the members of the arch and its two cantilever arms for a load of 1 kip at each of the panel points from one end to the centre of the span. As the secondary stresses are directly proportional to the magnitude of an external load in any given position, labor was saved by choosing the vertical loads at different panel points so as to give a vertical upward reaction of 1 kip at the left support. Ten cases were taken. In the first case the stresses were found for a horizontal reaction of 1 kip; in the other nine cases the stresses were found for vertical loads as follows: 1 kip for panel load No. 0; 2 kips for panel load No. 6; 2.4 kips for No. 7; 3 kips for No. 8; 4 kips for No. 9; 6 kips for No. 10; 12 kips at No. 11; 12 kips upward for No. 11′; and 6 kips upward for No. 10′. The stresses for a panel load of 1 kip at each panel point were found from the foregoing by combining the stresses due to corresponding vertical and horizontal reactions.

After the values of various terms required by Mohr's method for secondary stresses were obtained, the equations were formed for every joint of the truss for each case of loading. Accordingly, it was necessary to solve ten sets of thirty-four simultaneous equations. They were solved by the method of Gauss, as they have the same form as the normal equations in geodesy. This fact was first noted by Mr. José Páez, a graduate student at Cornell University in 1912-13, who combined a minor in geodetic engineering with his major in bridge engineering. Mr. Páez wrote a thesis on secondary stresses in which he made a critical comparison of all known methods for their computation, and applied each of them to the same truss. He also discovered an additional approximate method. By the method of Gauss, the solution of the equations becomes quite mechanical, and may be checked at every step of the process. This method of solution, therefore, has a great advantage over any other.

Mr. Mao made an additional simplification of the solution by numbering the joints in the left half of the truss as shown in Fig. 2, and numbering those in the right half of the truss so that the sum of the numbers for two

symmetrical joints is 35, or one more than the total number of joints. By arranging in a table with ϕ_1 to ϕ_{34} at the tops of the columns from left to right, ϕ_{34} to ϕ_1 at the bottom, the numbers of the joints from 1 to 34 on the left

Table 1.—Properties of Truss Members

Truss members.	Length, in inches.	Section area, in square inches.	Least radius of gyration, in inches.	Values of $\frac{2c'}{l}$.	Values of $\frac{2c}{l}$.	Truss members.	Length, in inches.	Section area, in square inches.	Least radius of gyration, in inches.	Values of $\frac{2c}{l}$.
U_2'	300	77.9	12.90	0.0936†	0.1145‡	D_2'	526	51.37	6.95	0.0381
U_1'	300	77.9	12.90	0.0936	0.1145	D_1'	665	51.37	6.95	0.0301
U_1	300	77.9	12.90	0.0936	0.1146	D_1	665	38.13	7 11	0.0301
U_2	300	77.9	12.90	0.0936	0.1145	D_2	526	35.63	7.10	0.0381
U_3	300	77.9	12.90	0.0936	0.1145	D_3	428	35.63	7.19	0.0467
U_4	300	99.2	10.00	0.0956	0.1122	D_4	370	38.13	7.11	0.0541
U_5	300	99.2	10.00	0.0956	0.1122	D_5	341	53.86	6.87	0.0587
U_6	300	99.2	10.00	0.0956	0.1122	D_6	332	63.05	8.78	0.0602
L_1'	341	49.0	9.73	0.1172	......	V_2'	432	65.3	8 80	0.0578
L_0'	360	73.4	10.10	0.1111	......	V_1'	594	77.8	9.13	0.0442
L_0	360	195.8	10.80	0.1111	......	V_0	792	118.4	8 70	0.0341
L_1	341	185.8	10.80	0.1172	......	V_1	694	85.9	9.02	0.0438
L_2	325	185.8	10.30	0.1230	......	V_2	432	44.0	8.57	0.0578
L_3	313	175.8	10.25	0.1278	......	V_3	306	44.0	8.57	0.0817
L_4	305	175.8	10.25	0.1310	......	V_4	216	44.0	8.57	0.1156
L_5	301	153.4	10.30	0.1328	......	V_5	162	44.0	8.57	0.1542
						V_6	144	29.6	6.95	0.1388

side from top to bottom, and the numbers 34 to 1 at the right side. Mr. Mao found that the coefficients were not only symmetrical with respect to a diagonal from the upper left corner to the lower right corner of the table, but also with respect to the horizontal beween the numbers 17 and 18. This arrangement saves nearly half the labor by reducing it to 18 equations instead of 34; it requires a table only one-fourth as large as otherwise, so far as coefficients only are concerned; makes a further saving in work in substitutions after some of the values are found, as one substitution gives the coefficients of two unknowns, the sum of the subscripts of which equals 35; it reduces the chance of making errors, as the number of terms to be considered is only half as large as otherwise; gives a more accurate result by avoiding so long a series of substitutions in finding the values of the first few unknowns; and saves time in verifying the check terms.

Fig. 3 gives the secondary stresses in the members of the arch truss, expressed as percentages of the corresponding primary stresses, the loading being such as to cause the maximum and minimum live-load stresses, those for positive primary stresses being shown in the upper part of Fig. 3, and those for negative primary stresses in the lower part. The secondary stresses are for the top and bottom fibres of the upper-chord members, for the top fibres of the diagonals and lower-chord members, and for the outer fibres toward the centre of the span in the verticals.

As the members of the cantilever arm have primary stresses due only to one or two live panel loads on the cantilever arm, and the secondary stresses are caused by panel loads over the entire length of the truss, it is necessary to give two sets of percentages for these members. One of these is the percentage of the primary stress for the maximum secondary stress in tension, and the other for that in compression. As U_2' has no primary stress due to vertical loads, the values for its secondary stresses are given as percentages of the primary stress in U_1' as both members have the same composition and section area.

It must be remembered that the values given in Fig. 3 are not all simultaneous, although a few of them are. To study the effect of secondary stresses on the design of any structure, it is most important to know the additional stresses thus produced when the primary stress in each member is either a maximum or a minimum. An examination of these figures shows that in the arch proper the secondary stresses in the upper chord do not exceed 2.56%; in the lower chord 0.85%; in the diagonals 0.75%; and in the verticals, exclusive of V_6, 4.28 per cent. The vertical, V_6, receives no primary stress except from panel load No. 6, hence two sets of secondary stresses are given, one the greatest positive and the other the greatest negative stress. Both sets really belong to the lower part of Fig. 3, as V_6 has no positive primary stress; but one set is transferred to the upper part of Fig 3, so as to facilitate comparison with the stresses in other verticals. In the cantilever arm the greatest secondary stress is 4.51%, except in U_2', in which it is 6.65 per cent. In U_2', however, there is no primary stress due to vertical loads, as stated in a previous paragraph.

In computing the secondary stresses, it is always assumed that at any joint the angles between the tangents to the elastic lines of members which meet at that joint remain unchanged. It would be very desirable to have some measurements taken to determine whether this assumption holds true when a truss with riveted joints is deformed under moving loads.

O. H. Ammann, M.Am.Soc.C.E., South Amboy, N.J.—The analysis of the painstakingly recorded stress measurements, made by Mr. Steinman, may lead the uninitiated reader to overlook the important fact that he has to do

Table 2.—Revised Primary Stresses

	U_2'	U_1	U_1	U_2	U_3	U_4	U_5	U_6
Dead load	0	+ 70.4	+ 117.8	+ 97.2	+ 73.8	+ 43.8	+ 13 3	0
Live load	0	+ 225.8	+ 489.1	+ 582.1	+ 652.4	+ 622.6	+ 406.6	+ 217.9
Impact	0	+ 122.7	+ 164.8	+ 183.1	+ 211.1	+ 206 5	+ 148.2	+ 72.6
Temperature (rise)	0	0	+ 24.6	+ 61.7	+ 117.4	+ 197.2	+ 288.0	+ 332.7
Live load	0	0	− 150.3	− 322.8	− 511.6	− 653.4	− 640.4	− 511.2
Impact	0	0	− 54.6	− 115.1	− 176.9	− 219 2	− 203.3	− 170.1
Temperature (fall)	0	0	− 24.6	− 61.7	− 117.4	− 197.2	− 288.0	− 332.7
Maximum	0	+ 418.4	+ 785.3	+ 924.1	+ 1 054.7	+ 1 072.1	− 1 118.4	− 1 014.0
Minimum	0	+ 70.4	− 112 2	− 401.9	− 731.6	− 1 026.0	+ 851.1	+ 623.2

	L_1'	L_0'	L_0	L_1	L_2	L_3'	L_4	L_5
Dead load	− 79.9	− 166.1	− 718.2	− 655.5	− 602.5	− 557.6	− 611.3	− 474.7
Live load	− 256.2	− 468.4	− 1 487.8	− 1 410.9	− 1 340.8	− 1 257.4	− 1 081 8	− 778.9
Impact	− 140.2	− 234.2	− 371.0	− 376.4	− 376.2	− 369.1	− 334.8	− 252.3
Temperature (rise)	0	0	− 88.6	− 112.1	− 147.1	− 199.7	− 275.6	− 362.1
Live load	0	0	+ 265.8	+ 309.2	+ 378.7	+ 452 7	+ 478.8	+ 372 2
Impact	0	0	+ 132.9	+ 137.2	+ 150.9	+ 173.2	+ 173.8	+ 127.8
Temperature (fall)	0	0	+ 88.6	+ 112.1	+ 147.1	+ 199.7	+ 275.6	+ 362.1
Maximum	− 476.3	− 868.7	− 2 665.4	− 2 554.3	− 2 466.6	− 2 383.8	− 2 203.0	− 1 868.0
Minimum	− 79.9	− 166.1	− 230 9	− 97.0	+ 72.2	+ 268.0	+ 416.9	+ 888 4

	D_2	D_1	D_1	D_2	D_3	D_4	D_5	D_6
Dead load	+ 123.2	+ 165.7	+ 47.1	+ 35.5	+ 33.5	+ 37.1	+ 34.6	+ 14 0
Live load	+ 395.0	+ 369.0	+ 332.9	+ 308.3	+ 280.6	+ 321.1	+ 473.4	+ 654.8
Impact	+ 215.9	+ 184.5	+ 120.5	+ 106.9	+ 76.9	+ 86.1	+ 143.7	+ 215.4
Temperature (fall.)	0	0	+ 54.6	+ 64.7	+ 79.7	+ 98.2	+ 102.7	+ 50.2
Live load	0	0	− 214.9	− 169.3	− 124.0	− 110.5	− 253.9	− 530.1
Impact	0	0	− 69.4	− 54.6	− 52 9	− 48.7	− 94.1	− 179.0
Temperature (rise)	0	0	− 54.6	− 64.7	− 79.7	− 98.2	− 102.7	− 50.2
Maximum	+ 734.1	+ 719.2	+ 554.9	+ 514.7	+ 470.7	+ 542.5	+ 754.4	+ 935.3
Minimum	+ 123.2	+ 165.7	− 291.8	− 253.1	− 223.1	− 220.3	− 416.1	− 754.4

	V_2'	V_1'	V_0	V_1	V_2	V_3	V_4	V_5	V_6
Dead load	− 120.3	− 156.8	− 252.0	− 81.1	− 71.1	− 67.7	− 64.0	− 53.7	− 41.8
Live load	− 445.8	− 465 6	− 613.3	− 392.9	− 346.1	− 312.7	− 331.5	− 376.8	−141.6
Impact	− 243.2	− 232.8	− 204.3	− 133.2	− 94.2	− 75.2	− 95.9	− 115.2	− 73.2
Temperature (fall)	0	0	− 48.8	− 53.2	− 56.9	− 57.4	− 48.8	− 21,6	0
Live load	0	0	+ 166.6	+ 137.7	+ 82 5	+ 47.9	+ 93.8	+ 189 7	0
Impact	0	0	+ 55.4	+ 67.3	+ 40.7	+ 26.1	+ 37.1	+ 69 5	0
Temperature (rise)	0	0	+ 48.8	+ 53.2	+ 56.9	+ 57.4	+ 48.8	+ 21.6	0
Maximum	− 809.3	− 855 2	−1 118 4	− 660.4	− 568.2	− 613.0	− 640.2	− 567.3	−256.6
Minimum	− 120.3	− 156.8	+ 18.7	+ 177.1	+ 109.0	+ 63.7	+ 115.7	+ 227.1	− 41.8

NOTE.—All stresses are expressed in kips, or units of 1 000 lb.

with an extremely special case, which may not repeat itself in the history of bridge construction. The author is led to conclusions relative to secondary stresses which, in the writer's opinion, are somewhat too far-reaching.

The case is that of the bottom chord of an arch of unusual proportions. The chord itself has an unusual section in size and shape. The joints of the chord members are

unique, and the method of assembling the trusses, their erection, and the method of replacing the drift-pins with rivets—all of which features largely affect the secondary stresses—are so special that it is hardly conceivable how conclusions can be drawn applying to arch trusses as a type, and even to bridge structures in general. Furthermore, only the dead-load stresses have been investigated.

This is in no way meant to lessen the value of the measurements or the presentation of the results; on the contrary, if the conclusions drawn by the author are taken to apply strictly to the case under investigation, or to very similar cases, they are infinitely more valuable than if generalized.

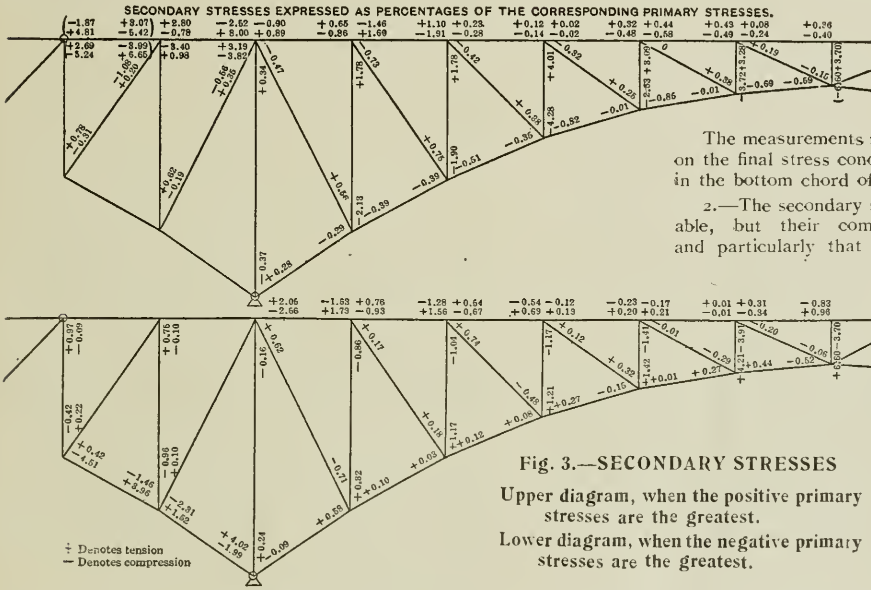

Fig. 3.—SECONDARY STRESSES

Upper diagram, when the positive primary stresses are the greatest.
Lower diagram, when the negative primary stresses are the greatest.

It may not be amiss to state here briefly the development of this investigation, with which the writer has been in intimate touch since its inception.

When Mr. Lindenthal first mentioned to the writer his intention of making strain measurements on the Hell Gate Arch, the simple object to be attained was to determine in how far the stresses in the statically indeterminate structure would agree with those calculated. Incidentally, the actual bending stresses due to the rigid joints were to be obtained. This naturally referred to the live-load stresses in the completed statically indeterminate two-hinged arch, because, up to that time, no measurements of dead-load stresses were known to have been made, and it was questionable whether any of the existing instruments would be suitable for that purpose.

After preliminary investigation, however, the measurement of dead-load stresses was found to be feasible. In view of the fact that such stresses form the greater portion of the total stresses, the programme was enlarged to embrace, not only the final dead-load stresses, but also those at the various erection stages. The derivation of the actual secondary stresses from those measured was a secondary development.

It was realized, however, that to carry this programme through completely for the two arch trusses would require an excessive sacrifice of time and expense. It was decided, therefore, to confine the measurements to a number of bottom chord members, in view of their preponderant importance and unusual features. Even the programme as carried out involved considerable expenditure, and Mr. Lindenthal cannot be given too much credit for having taken this burden on his own shoulders for the sake of scientific research.

The important facts established beyond question by the investigation are the following:—

1.—The measurement of dead-load stresses is feasible, and, for practicable purposes, gives sufficiently close results, provided the stresses are large enough so that the personal factor and other disturbing elements incidental to the measurements become comparatively negligible.

The measurements made are a fair check on the final stress condition from dead load in the bottom chord of the Hell Gate Arch.

2.—The secondary stresses are measureable, but their complete determination, and particularly that of the effect of the various influences, such as method of erection, type of joints, method of replacing drift-pins by rivets, etc., requires far more numerous measurements than have been feasible without undue cost in the case of such a large structure as the Hell Gate Bridge. For this reason only hypothetical conclusions can be drawn from these measurements as to the magnitude of secondary stresses in arch trusses and bridge structures in general.

The measurements have corroborated the expectation that the secondary stresses in the bottom chords of the Hell Gate Bride are negligible, that is, are more than covered by the margin of safety of the primary stresses.

3.—The measurements have proved the expected favorable action of the three-face joints of the bottom chord, with regard to avoiding dangerous edge pressures and reducing the secondary stresses.

One important object has not been accomplished, namely, the determination of the actual stresses in the statically indeterminate structure. The dead-load stresses are statically determinate—at least, very nearly so—because such stresses, superimposed after the trusses were converted from two-hinged to three-hinged arches, are very small. In the writer's opinion, it is highly desirable that the measurements be continued so as to embrace the statically indeterminate live-load stresses. They would furnish valuable additional information. As the expense for such further investigation is too heavy for an individual engineer, it should be carried out either by the United States Bureau of Standards or by an engineering society in co-operation with the railroad.

VOCATIONAL TRAINING BY ENGINEERS

PROF. H. E. T. HAULTAIN, Toronto, has addressed the following letter, under the caption, "This is an S.O.S. call from an engineer to engineers," to the branch secretaries of the Canadian Society of Civil Engineers:—

"Last July, W. E. Segsworth, mining engineer, whom I have known for twenty years, a man of independent means who made his money cleanly, took an active interest in the vocational training of the returned soldier, which at that time was in a very lame and halting way. He was appointed administrator of the vocational branch of the Military Hospitals Commission, a Dominion Government commission. His jurisdiction extends over the whole of Canada.

"In September he appointed me vocational officer in Ontario without pay, the University loaning me for the purpose.

"We have employed engineers on our staffs wherever we could get them. I have sixteen on my staff throughout Ontario and I am more and more convinced that the problem of getting the returned crippled soldier back into civilian life can be handled better by Engineers than anybody else.

"The problem is a very much bigger one than anybody realized. When I took hold they told me that part time and a small office staff would organize the proposition. I now have a staff of over one hundred exclusive of teachers and instructors and it is still growing.

"The appointment of Mr. Segsworth is probably the first time that an engineer has been appointed to an important government position apart from purely engineering work. We are suffering from all the difficulties of the pioneer in any new work. Those men of standing who have been near us and seen our work and its results approve, but there are many others, politicians, ambitious doctors and others, who are knocking, and we need all the support we can get. Being engineers, we are very poor hands at window dressing or publicity.

"Please support the engineer in this effort at public service."

The Toronto-Hamilton-Buffalo, Canadian Northern and New York Central Railroads have formed a company under the name of the Canadian Niagara Bridge Co., to build a new bridge over the Niagara River, near Bridgeburg, Ont.

Replying to a question by Mr. Lemieux, Hon. Frank B. Carvell, Minister of Public Works, expressed the opinion last week in the House of Commons, Ottawa, that after the war, Federal departmental buildings should be constructed in large centres such as Montreal, Toronto, Winnipeg and Vancouver, with the idea of finding accommodation in them for all Dominion government offices.

All records for rapid ship construction are said to have been broken when the 5,548-ton steel collier "Tuckahoe" was launched last Saturday at the Camden, N.J., yards of the New York Shipbuilding Corporation. The keel was laid on April 8th, and only twenty-seven days were required to prepare the hull for launching. The boat was 90 per cent. completed when launched. It will be ready for a cargo about May 20th.

The Canadian Niagara Bridge Company's incorporation bill met with no opposition from the railway committee of the House of Commons, Ottawa, but aroused considerable discussion as to its position. An amendment dealing with this matter was inserted to provide that the boulevard of the Niagara Falls Park Commission shall not be interfered with, except with the consent of the park commissioners and, failing that, the plans will be subject to the approval of the Dominion Railway Board. It is estimated that the bridge will cost approximately $7,000,000.

GOOD ROADS CONGRESS

THE Fifth Canadian Good Roads Congress, which is being held this week at Hamilton, Ont., was opened at 2.30 p.m. last Tuesday with addresses by Hon. Findlay Macdiarmid, Minister of Public Works and Highways, Province of Ontario; W. A. McLean, Deputy Minister of Highways, Province of Ontario; B. Michaud, Deputy Minister of Highways, Province of Quebec; Very Rev. Monsignor J. M. Mahony, Hamilton; Rev. Canon Daw, Hamilton; Charles G. Booker, Mayor of Hamilton; S. L. Squire, representing the Canadian Good Roads Association; C. R. Wheelock, president of the Ontario Good Roads Association; R. T. Kelley, president, Hamilton Board of Trade; L. B. Howland, president, Canadian Automobile Association; and M. J. Overell, president, Hamilton Automobile Club.

Yesterday was the first day of technical discussion. At 9.30 p.m. resolution and legislation committees were appointed. At 10 a.m. C. R. Wheelock, president of the Ontario Good Roads Association, delivered an address on "Who Should Pay For the Road?" followed by a discussion lead by H. Bertram, of Orangeville, Ont., a member of the Toronto-Hamilton Highway Commission.

Col. William D. Sohier, chairman of the Massachusetts Highway Commission, read a paper on "The Efficiency of the Highway in the Present Transportation Difficulties."

At 1 p.m. the Canadian Automobile Association held its annual meeting. At 2.30 p.m. F. Howard Annis, of Whitby, Ont., spoke on "Highway Widths."

"How the Good Roads of France are Helping to Win the War" was the title of a paper by Lieut.-Col. W. G. McKendrick, D.S.O. Prof. Arthur H. Blanchard, consulting highway engineer, of New York City, delivered an address on "English and American Practice in the Construction of Tar Surfaces and Pavements."

At 7.30 p.m. the annual dinner of the association was held at the Royal Connaught Hotel.

C. A. Mullen, director of paving department, the Milton L. Hersey Co., Limited, Montreal, opened to-day's session at 10 a.m. with a paper on "Asphalt Pavements." James H. MacDonald, ex-state highway commissioner of Connecticut, lectured on "Drainage,—The Most Important Consideration Entering Into Road Construction."

At 2.30 p.m. L. B. Howland, president of the Canadian Automobile Association, spoke about "What motorists can do to help the road movement and relieve the transportation congestion." W. H. Connell, consulting engineer, Philadelphia, discussed the results of tests with various types of pavements. A. Lalonde, C.E., assistant engineer of the city of Outremont, P.Q., delivered an address on Concrete Roads."

At 8.15 p.m. the Canadian Good Roads Association held its annual meeting.

The last session of the congress will be held to-morrow morning, May 10th. Three technical papers are on the programme for this session, namely, "The Hot Mix Method of Bituminous Construction Using an Asphaltic Binder," by E. Drinkwater, municipal and highway engineer, St. Lambert, P.Q.; "Abatement of the Dust Nuisance," by E. R. Gray, city engineer, Hamilton, Ont.; and "Roads for the Common People,—Gravel and Macadam," by Paul D. Sargent, chief engineer, State Highway Commission, Augusta, Me.

The fuel controllers of the United States and Canada have jointly decided that no American anthracite coal be shipped during the present coal year to points in Canada west of Winnipeg.

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Principal Contents of this Issue

DRYDOCK AND SHIP-REPAIRING FACILITIES AT HALIFAX

IN British North America the only two drydocks on the Atlantic coast are those at St. John, Newfoundland, and Halifax, Nova Scotia. Both were built about thirty years ago at the instance of the British Admiralty and under Imperial subsidy. Needless to say, both docks are now rather antiquated and incapable of accommodating the larger boats on the Atlantic routes; and the explosion at Halifax did not improve the dock at that port.

A new modern drydock capable of serving boats of at least 30,000 tons, should be built immediately at Halifax, together with the shops necessary for the speedy repair of modern marine machinery. There are at present no machine shops in Halifax capable of handling modern marine work.

Another prime necessity is a floating crane or shear legs of 75 tons capacity. There are absolutely no lifting facilities of this nature to-day in Halifax. For certain special war needs that arose some time ago, cranes had to be borrowed from Quebec harbor and towed to Halifax.

In coaling facilities, the conditions at Halifax are nothing less than criminal shortsightedness considering that we have been at war for three years and nine months. The only modern coaling plant at that port is the one owned by the Dominion Coal Company, which is limited in capacity and now overloaded. Old-fashioned methods still prevail. Important ships calling for coal are often delayed a week, or even much longer, through lack of modern facilities. When modern colliers, with mechanical discharging devices, call at Halifax, they are often delayed for days, as the coal cannot be taken from them as rapidly as they can put it ashore. Had Halifax been properly equipped, Canada could have rendered notable Imperial service last winter when hundreds of ships were tied up at American ports awaiting coal; but Halifax had no coal reserves.

The development of the port of Halifax is not only a matter of prime importance to Canada's future growth, but it is also an urgent war measure. Some of the reasons for this statement were explained briefly in the editorial regarding "Double Tracking the Intercolonial Railway," which appeared in our issue of April 18th. But Halifax will never be capable of rendering proper service to Britain's navy and Allied shipping until far more extensive drydock and ship-repair facilities are there established.

A ship-building yard should be located at Halifax. There is no other way in which a steady, plentiful and economical supply of labor can be assured for ship repairing. Workmen can be transferred at a moment's notice from ship-building to ship-repairing jobs. Ships are being built, or are about to be built, at practically every port in Canada except Halifax,—the port that needs ship-building the most, and that nature built most ideally for the purpose.

The dangers of navigation in the vicinity of the Eastern coast of Canada are notorious, and if the Canadian ports do not offer ample protection in every way possible to ship owners, ensuring speedy repair for damaged ships, then trade after the war will go through other channels. Damaged boats arrive at Halifax continuously and are unduly delayed. Many of these boats are often towed to American ports at great expense and loss of time.

To-day an average tramp of, say, 8,000 tons is worth at least $3,000 daily, yet such boats are often delayed for many weeks at Halifax, awaiting their turn at the drydock. Shortly after the Halifax explosion there were in the harbor ten ships awaiting drydock, and it was estimated that those ten ships lost a million dollars in the first month after the explosion, on account of the delay. At least one of them has not yet been docked.

The whole problem of drydock and ship-repairing facilities at Halifax should have the immediate attention of the government. If enough money for the purpose cannot be set aside from the last Victory Loan, then a special loan, specifically earmarked for the work, should be floated at once, either in the United States or at home. If the public were properly educated regarding the urgency of the need, the comparatively small amount of money required could be readily obtained in Canada.

DEVELOPMENT OF NIAGARA

IN a recent issue of the Electrical World, of New York, Dr. Charles P. Steinmetz, the wizard of the General Electric Company, predicts the ultimate use of all the hydraulic power that can be generated at Niagara. Dr. Steinmetz's suggestion, which he says was made about fifteen years ago, and then not taken seriously, is that Niagara should be developed completely, say, to about 10,000,000 kw., making the falls run dry; but that the power plants should be shut down, say, to 10 per cent. of full capacity, on holidays and Sundays, allowing the falls to resume their natural form for the edification of visitors. To laymen, the proposal to turn Niagara Falls on and off periodically may appear humorous, but the recent experiences in fuel and power shortage, and the possibilities of railroad electrification and electro-chemical and electro-metallurgical work, will sooner or later force all to agree that the scheme proposed by Dr. Steinmetz is demanded in the national interest.

PERSONALS

W. H. EASSIE, city engineer of Cranbrook, B.C., has resigned.

Major E. W. W. DOANE, formerly city engineer of Halifax, has been asked to return from overseas for work in connection with the reconstruction of Halifax.

H. P. CREIGHTON has been appointed buildings and bridges master for the Canadian Pacific Railway, Algoma district, with headquarters at Schreiber, to succeed E. T. Draper.

W. J. DICK, M.Sc., has resigned as mining engineer to the Commission of Conservation, Ottawa, to accept a more remunerative position as sales manager of Coal Sellers, Limited, Winnipeg.

G. L. GUY, M.Can.Soc.C.E., has assumed the duties of secretary of the Manitoba Branch of the Canadian Society of Civil Engineers, in place of A. W. Smith, who has resigned as secretary-treasurer.

A. T. SMITH, until recently manager of the R.U.V. Co., New York City, has rejoined the Permutit Co., with which firm he had been previously connected, to take the position of assistant manager of sales.

JOSEPH LABELLE, B.A.Sc., formerly designing engineer of the Structural Steel Co., Limited, has been appointed sales engineer of the Canadian Bridge Co., Limited, in connection with the latter firm's Montreal office.

W. STANLEY VIPOND, M.Sc., assistant chief engineer of the Northern Electric Co., Montreal, has left for overseas service with the Royal Flying Corps. Mr. Vipond is a graduate of McGill University, class of 1908.

T. COOPER, B.S.A., has been appointed drain and soil expert for the counties of Welland, Haldimand, Oxford, Norfolk, Lincoln and Wentworth. His office will be at the Department of Agriculture, 19 Market Street, Hamilton.

Lieut. BERNARD MOBERLY, of the Railway Construction Corps, is a prisoner of war, according to advices received by his father, Frank Moberly, of the engineering staff of the Federal Department of Public Works. His home is in Barrie, Ont.

E. S. FRASER, town engineer, New Glasgow, N.S., has been presented with an engraved gold watch by the citizens of Dartmouth, N.S., in acknowledgment of assistance rendered during the days following the explosion in Halifax harbor.

Flight-Lieut. CHARLES ST. CLAIR PARSONS, who is reported missing while flying in France, graduated from Woodstock College as silver medalist. At the time of his enlistment he was a student in Applied Science, University of Toronto, with the class of 1919.

E. S. ESTLIN was in Windsor, Ont., district during the past week to investigate the natural gas situation on behalf of the Ontario government. He collected data regarding the quantities of gas consumed in 1917 and this year to date, and the processes for which it was used.

Lieut. W. A. SMELSER, B.A.Sc., '16, of the University of Toronto, who has been serving as instructor in machine gunnery in the Canadian Officers' Training Corps, and Lieut. A. A. TUFFORD, B.A.Sc., '17, University of Toronto, both of Hamilton, have been given commissions in the Canadian Engineers and will soon go overseas.

Capt. THOS. S. SCOTT, B.A., B.Sc., has been ordered to report at Halifax to aid in the reconstruction work in that city. Capt. Scott has been professor of civil engineering at Queen's University for several years, and was for some time assistant city engineer of Toronto, and subsequently manager for British Columbia for Warren Bros. Co.

Sergt. FRANK S. MERRY, who enlisted as a gunner in the Canadian Field Artillery, and went overseas with the Second Contingent, has been given his lieutenancy and attached to the 1st C.I., France. He entered the University of Toronto from Stratford with class '16 Applied Science and was previously serving on the western front with the 25th Battery, 4th Brigade.

A. R. DUFRESNE, assistant engineer of the Federal Public Works Department, accompanied by Captain Robertson, agent of the Department of Marine and Fisheries in British Columbia, and Mr. Mitchell, engineer of the Public Works Department, made a tour of inspection of the Nanaimo harbor recently in company with F. H. Shepherd, superintendent of dredges.

Major GEORGE W. MACLEOD, who was given the D.S.O. for supervising an assault and strengthening a captured position, entered the University of Toronto from Parkhill, with class '07, Applied Science, but went overseas from Edmonton with the 49th Battalion, in which he enlisted as a lieutenant. He has been serving in France, and was reported wounded in September, 1916.

Lieut.-Col. R. W. LEONARD, of St. Catharines, has donated $100,000 for the establishment of "the Leonard Foundation" at the Royal Military College, Kingston, Ont. The object of the foundation is to assist the education of the sons of clergymen, of non-commissioned officers or privates of the permanent British or Canadian army or navy, and of veterans who have taken part in any of the British Empire's wars.

JOHN WILLIAM SEENS, B.Sc., C.E., has been appointed sales manager of the Canadian Bridge Co., Limited, of Walkerville, Ont., with offices in the New Birks Bldg., Montreal. For the past seven years Mr. Seens has been manager of the Structural Steel Co., Limited, of Montreal, which company discontinued operations last fall on account of being obliged to surrender their leased shop. During the period under Mr. Seens' régime, the Structural Steel Co. successfully carried out the fabrication and erection of many of Montreal's largest buildings. They also furnished the bulk of the steel work in connection with the large paper mill development in recent years in Quebec and Eastern Ontario.

REPORT ON LIQUID CHLORINE

(Continued from page 416)

with chloramine. The advantages of each system of treatment might be summarized as follows:—

"Liquid Chlorine—(1) Automatic control; (2) elimination of dirt in empty bleach drums; (3) elimination of sludge; (4) requires less expert control.

"Chloramine—(1) Large margin of safety; (2) no undergrowths; (3) facility for diversion of portion of chloramine to low-lift station (an advantage arising solely out of local conditions of lay-out of plant).

"To put in a liquid chlorine apparatus of sufficient capacity to handle all the water supply of Ottawa would cost $5,000. Personally, I am in favor of changing to liquid chlorine, but the direct recommendation would have to come from Mr. Race (the city's chemist and bacteriologist) if this change is considered by your board."

In view of Mr. Macallum's statement that he is in favor of the liquid chlorine treatment instead of the chloramine, the controllers authorized him to call for tenders for supplying and installing liquid chlorine apparatus.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

ROAD BUILDING AT THE FRONT

How the Good Roads of France are Helping to Win the War—Planks and Large Stone the Most Valuable Material—Address Delivered Last Week in Hamilton, Ont., at the Fifth Canadian Good Roads Congress

By LT.-COL. WILLIAM G. MacKENDRICK, D.S.O.
Director of Roads, Fifth British Army

MY first job of road-building in France was for the Canadians. I was put in charge of a thousand Belgian refugees—civilians—who were paid four francs each per day for working on the roads. I had not handled men for fifteen years, but I was puzzled to know why I could not put more vim into their work, until I found that these men had to walk from seven to twelve miles per day before they reached their work, and then walk that distance back home again in the evening. Was it any wonder that they had no energy left for their work?

Although I had considerable territory to cover, and a large number of workmen to watch, I could not get a motor or a horse. I simply was not on the list of army officers who were entitled to a horse or a motor, and that settled it. I did succeed, however, in arranging for motor lorries to collect my workmen, and within a month the work showed very satisfactory results.

Introducing Business Methods

These Belgians were divided into thirty-two gangs, with a foreman for each gang. At the end of the month, the paymaster handed in cash to each foreman the pay for his gang without any check whatever upon whether the cash reached its ultimate destination, and without any check on the number of men employed or the hours which they worked. We changed these methods and appointed soldiers as time-keepers, and saved John Bull & Co. something like 30,000 francs per month in the pay roll by cutting out the loafers, etc.

Moreover, modern methods of handling those men greatly increased their output. We had six gangs working in the woods getting out defence pickets, posts and other timber. We almost trebled their output. We had ten gangs in the quarries getting out stone and we trebled their output. The other sixteen gangs were on the actual road-making, and we doubled their output. The Belgians, when given proper superintendence, make excellent workmen.

"They Handed Me a Lemon"

Before the war the French roads were in good repair, but they were greatly overworked, even the routes Nationale. The heavy guns ground the stone to powder and the roads went to pieces fast, especially in the spring and fall. In the fall of 1915 the British army had to stop fighting because they could not carry the needed material over the roads. Sir Eric Geddes reported on the situation, and after he had made his report the British Cabinet asked him to carry on the work and take charge of all the transportation in the British armies, including standard railways, light railways and roads.

In 1916 I was sent to the Somme to make roads for the Fifth British Army. The job they handed to me was a "lemon." There were 250 miles of broken-down roads that they had been fighting over for months. The stuffing of these roads was gone, and they wanted them re-built so that they could fight over them again within three months. The centre of the road was often a ditch holding water and mud from 8 to 10 inches deep, of the consistency of pea soup.

No Crown, No Road

General H. P. Maybury, the chief engineer of the English Road Board, went over fifty miles of these bad roads with me in two days. I urged him to give me the men and materials to put a crown on them and then they would be alright. He said, "You seem to think that a crown is everything."

"Yes," I replied, "with it you have a road; without it, you have—not."

We gathered all the officers of the various corps and told them what we wanted done; nevertheless, we could not get sufficient stone. But for five miles of the road leading out from Acheux, we picked the stone off the outer 6 feet of each side of the road and threw it to the inner 6 feet, so that we had 12 feet of fairly good road in the middle. The director of roads gave us four and five times the quantity of stone we had before, and timber as required, so we never lacked material to work with after he took charge.

Making Roads With Material from Ruins

The army did not take kindly at first to the new department which had taken over the road work, but when they saw what it was accomplishing, we got their hearty co-operation.

They told me that for me, a lieutenant-colonel, to take a pick from a private's hand and show him what I wanted done, would prove ruinous to army discipline. But it didn't, and within a month we had 12,000 men working to the one idea and with the one policy, and doing fine work for the use of the fighting troops.

When "the big push" was on we could not get stone. As a result we canvassed the surrounding country for everything that could be put onto the roads. Consequently, there are many villages of which not a single brick, stick or stone is left. We took the bricks from the

houses and from the ruins and put them on the roads. We carted the stones from the broken walls. The army, as they advanced, used all the wood for fires to cook their meals, etc. We used the larger timbers, roof-rafters, etc., to fill up shell holes and to plank muddy places. It is a fact, therefore, that of many villages there is not a trace, virtually not one stone being left on top of another. One village of 2,000 inhabitants, that I have in mind, has disappeared absolutely with the exception of a piece of granite block which was laid where the centre of the village had been.

Used Planks on the Worst Roads

The road north from Albert to Bâpaume was for a time the only line of communication to the British front, and everything that went up to the army travelled over that road. At the end of the third day I drew attention to the fact that the road would not last two days more. It was built of four inches of gravel on sand foundation on clay. The caterpillars, weighing 17 tons, shook it to pieces with their incessant pounding. We had previously had 300 motor lorries on our road work, but they had taken away all but 23, and I had a strenuous time getting 200 more and stone to fix that road, but we finally got it rebuilt and in splendid condition.

Altogether, I had 764¾ miles of army roads under my care at that time. Besides the motor lorries, we had about 300 general service wagons, 56 road rollers and 12,000 men.

Many of these roads were blown to pieces by the Germans. When I first went to Flanders I saw that planks were the only thing that would save the situation, but I could not get the planks. "With five miles of plank, I will take the corps anywhere," I said, but there was no plank to be had. A plank road costs less, and can be built twenty times as fast, and over some kinds of ground will carry traffic that stone will not carry. The shell holes on some of the roads were from 5 ft. to 15 ft. in diameter. When it rained for a week, as it would, these holes would fill with water and stay full. I pointed out how impossible it was to build macadam roads under these circumstances, and asked for planks. When the new transportation department, under Major-General Sir Eric Geddes, got to work, they secured millions of railway sleepers for road-building; also 3-inch planks, which were used by all the armies in their advances on the western front. Sir Douglas Haig, in his despatches since then, has told of the value of those plank roads to the British army. At Vimy Ridge, Passchendaele and Messines, he said, the army could not possibly have advanced without them.

Road-Builders Saved Verdun

We found the method of building a Telford road in France, putting the stone on edge and then using small stone on top, did not carry the heavy lorry traffic. Even twenty or thirty inches of stone so placed did not hold the road up in place. We, therefore, changed the method and laid stones on their flattest side, then filled in 4-inch stone on top for a total depth of nine inches, putting a good crown on the stone and rolling where possible. Under these methods, we found that we were getting much better roads for one-third the cost, and that our roads would carry the heaviest kind of motor traffic.

The stone was mostly a soft limestone. In six weeks even 6 inches of this stone would be ground to powder and blown away. We found that 4, 5 and 6-inch stone were the best sizes to carry the motor traffic for soft spots. The 2-inch stone would "mush up" in wet weather, having too small a base and not enough bearing power to carry the traffic.

In this connection I may say that the French are, in my opinion, the finest road repairers in the world. They are economical in road-building, as they are in everything else. They make a barrow-load of stone go as far as we usually make a cart-load go. Their system of incessant vigilance and of patching of small holes effects great economies.

At Verdun the French road-builders undoubtedly saved the day. The Germans had totally interrupted their railway transportation on what was then the only railroad leading up to the French front at that point. A French road engineer organized regular schedules of motor freight trains. The trains left at definite intervals, just as on a railroad, and ran to schedule. If a motor broke down or was delayed, it was shoved to the side of the road. In this way supplies of materials of all sorts were kept up for three months, and this was undoubtedly the saving of Verdun, and thereby the saving of Paris,—and probably the saving of world civilization.

Open For Traffic Every Day

In the spring of 1916, army traffic was badly held up owing to the frost coming out of the ground. All traffic is kept off the roads for three days while the frost is coming out, and often it is necessary to keep the heavier traffic off for as much as ten days, but in the spring of 1917 we were able to keep all of the roads open for traffic every day.

We used all classes of labor, including German prisoners, Indian cavalry, West Indians, Chinese and English and Canadian labor battalions, but I found the Canadian labor best of all. It is more adaptable and keener to get on with the job, whether it be fighting, building roads, or the special work for which they are using the railway construction troops so much and so effectively on the fighting fronts.

[Note.—In order to avoid the publication of any military secrets, we submitted the full report of his speech to Col. MacKendrick for his revision. Unfortunately, Col. MacKendrick was too modest, we fear, and eliminated many of the most enjoyable parts of his address. As a result, the above abstract does not truly represent the witty and most interesting speech which he made at Hamilton, nor does it do justice to the splendid service which he has rendered at the Front and for which he was awarded the Distinguished Service Order.—Editor.]

The Brantford Board of Trade has indorsed a resolution calling for the immediate appointment of a town-planning commission for that city.

The industrial development section of the Vancouver Board of Trade is undertaking a special study of the problem of cheap housing of industrial employees.

The following utilities' estimates have been passed by the city council, Edmonton: Electric light, $46,890; telephone, $28,930; waterworks, $17,233; street railways, $1,541,439; total, $1,634,492.

At a meeting of the Ontario Railway and Municipal Board held this week, a letter was received from Bowman and Connor, who were the consulting engineers to the township concerned, approving the Toronto and Hamilton Highway Commission's plans for the Bronte bridge, provided that certain very minor changes be made. As the plans also have the approval of the Ontario Government, the contract will soon be let for the construction of this bridge. Action was deferred in regard to the Etobicoke, Port Credit and Mimico bridges pending report by Frank Barber, who is the consulting engineer for the municipalities interested in those bridges.

CANADIAN GOOD ROADS CONGRESS

At Fifth Annual Session, Held Last Week in Hamilton, Ont., War-Time Problems Were Discussed—General Report of the Proceedings—S. L. Squire Succeeds J. Duchastel as President

LAST week was "road week" in Canadian engineering circles. The fifth Canadian Good Roads Congress was held at Hamilton, Ont., and was attended by approximately 400 road enthusiasts (of whom, it is to be noted, only about 40 were from Hamilton), including the officials of the congress, speakers, exhibitors, motorists, municipal and highway engineers, road superintendents and road contractors.

Although the attendance was considerably smaller than in most previous years of the congress, the sessions were fully as interesting and the discussions even more general. From the standpoint of comfort, this congress was the best ever held in Canada, all who attended being unanimous in their approval of the idea of eliminating the heavier exhibits, which require the use of a large hall. Larger halls are generally cold and uncomfortable, whereas the ball-room of the Royal Connaught Hotel was an ideal place for the meetings. The room was attractively decorated, the exhibits being arranged along the two sides and across one end, with the stage at the other end.

Exhibitions Were Attractive and Educative

Following is a list of the exhibitors:—

Auto Road Construction Co., Niagara Falls, Ont.; The Barrett Co., Toronto; Hugh Cameron & Co., Toronto; Canada Cement Co., Montreal; Canadian Fairbanks-Morse Co., Montreal; Constructing and Paving Co., Toronto (in conjunction with the Godson Contracting Co., Toronto, joint exhibit); Dominion Good Roads Machinery Co., Goderich, Ont.; Imperial Oil Co., Toronto; Alfred Rogers, Ltd., Toronto; Sawyer-Massey Co., Hamilton; United States Steel Products Co., Toronto; and Warren Bituminous Paving Co., Toronto.

The booths were attractively furnished and decorated, the exhibitors distributing catalogues and samples and showing photographs of their products and factories. Various methods of testing materials were demonstrated, and sections of different kinds of roadway were shown.

The addresses by the various speakers were not entirely technical, but were intended to be informative for the general public, particularly for highway foremen and others actively interested in the improvement of roads and streets.

Opening of the Congress

Capt. J. Duchastel, city engineer of Outremont, who was president of the Canadian Good Roads Association for the past year, called the congress to order Tuesday afternoon, May 8th.

Mayor Booker, of Hamilton, extended the official civic welcome. He referred to the excellence of the Hamilton pavements, but deplored the practice of tearing up good pavements to lay water mains, sewers, etc., and he urged that a law be passed preventing the tearing up of new pavement, so as to make it necessary for cities to exercise foresight in installing water mains, sewers, gas mains, telephone conduits and other civic utilities.

W. A. McLean, deputy minister of highways for Ontario, and past-president of the Canadian Good Roads Association, addressed the meeting, stating that new traffic makes road construction an ever-changing subject. His speech in full will be found on page 436 of this issue.

James H. McDonald who until four years ago was state highway commissioner of Connecticut, extended greetings from the governor of his state.

B. Michaud, deputy minister of highways for the province of Quebec, spoke as follows:—

"I did not know that I had been selected to speak this afternoon, and I am somewhat tempted to blame the president, but I see this would be out of tune, as I think we owe a compliment to the president. I am glad to have this opportunity to congratulate him for the good work he has done in organizing the association on a legal basis, and also for having succeeded during these hard times in organizing this convention.

Would Pave With Roses

"I see there is a new feature—we have ladies amongst us, and I consider this a very favorable auspice for the convention of the roads. The first-class bituminous concrete road, the concrete road, the waterbound macadam with pot holes, the gravel roads with ruts, the trail made of clay and water,—all these roads will be dear things to us so long as they bring to us the loveliest and fairest half of the human family.

"On the other hand, I would assure them that we road men will always work to improve the roads and to maintain them in good order. If I were allowed a little sentiment, I would suggest that we should lay roses on the roads over which the ladies travel.

"Every time I have attended these conventions I have been called upon to speak of the work we have done in the province of Quebec as regards road construction, but I will refrain from it to-day. I was much embarrassed when I found that I had been selected to speak, and being in trouble, I looked for help and on the table in my room I found a Bible. I read that the great King Solomon said there is a time to cast stones away and there is a time to gather stones together. That is the secret of the road policy of the province of Quebec. Five or six years ago we made up our mind that the time had come to put stones together. Unfortunately the specification made by King Solomon was lacking in completeness, for he did not specify how we should keep the stones bound together. Of course, it has often been my lot to discuss and criticize specifications drawn up by people who knew more than I did, and so I would not venture to criticize those made up by King Solomon. I think perhaps he left that to the engineers of his time, but I must say that the construction of macadam roads should be a matter of discussion in this convention. I am sure all of you will discuss and criticize the various methods with care and in earnest.

"I hope you will upset the present methods, provided you can find better ones. At all events, I am sure that you all in this province and all the people of the Dominion of Canada will continue working hard toward the improvement of roads."

"Melting Pot of Public Opinion"

The Rt. Rev. Monsignor Mahony, of Hamilton, was on the programme for an address, but was unable to be present on account of an illness which later proved fatal. He died while the congress was in session, and suitable resolutions were passed in that connection.

Rev. Canon Daw, of Hamilton, who had also been asked to speak, was not able to be present.

Delivering the address of welcome on behalf of the Canadian Good Roads Association, of which he was vice-president for the past year, S. L. Squire, municipal adviser to the Ontario Government, said:—

"We look on these conventions as being the melting pots of public and private opinion in their relationship to highways. We find in conventions such as we are holding, men meeting who have diversified ideas, and although in some instances there seems to be no possible way of bringing all their ideas into harmony, still we believe that we can ultimately accomplish that which may now seem to be the impossible.

Opinions Differ, But All Welcome

"There may be men in this convention who would advocate the coast-to-coast highway, a highway which might bring the Atlantic and the Pacific together by a road over which traffic could be carried easier than by the railroads which we have. There are men who believe that the federal government should undertake that work as a public work, and we have the profoundest respect for the opinions of such men and welcome them to this convention. There are other men who are likely just as sincere as those who advocate this national transcontinental highway, who believe that we for a long time to come are, as a nation, not in a position to attempt any such public work. The men who do not agree with those whom I have first referred to, are welcomed also. We welcome them because we know that in each province they may have their own particular troubles and difficulties, and if they will bring their troubles and difficulties and cast them into this great melting pot, it is just possible that we will learn to know each other better and help each other to solve the difficulties which, after all, have a national aspect.

"There are those who consider the road from the standpoint of how we should legislate for the people, how we should undertake the work or what statutes we should place on our books. There are those who have a commercial interest in the highway. We welcome those. Perhaps some view it only as a means of pleasure, and shall we say that we have no use for those? Not at all. We look on every man interested in the improvement of roads as being with us. We welcome you all, whether your interests are commercial, national, provincial or local, with a personal and financial aspect or for the good of the whole people.

"If we all contribute our little bit, we hope that the dross shall be taken from that opinion and from it be drawn only the pure gold which shall make for the betterment of mankind. I am very glad we have such a representation from Quebec. Some people may have imagined that there is a difference of opinion in Canada between the French and the English. I want to say that after all there may be differences of opinion, but only such differences as we may find in families and communities, for while we may disagree in some little things, I am safe to say we agree in the things which go to make up a great nation."

Roads are Cheaper in California

C. R. Wheelock, president of the Ontario Good Roads Association, and Hon. Findlay Macdiarmid, minister of public works and highways of Ontario, both of whom had been scheduled to deliver addresses, sent messages of regret that they were unable to be present.

R. T. Kelley, president of the Hamilton Board of Trade, spoke about the importance of good roads as a factor in the campaign for increased production.

L. B. Howland, president of the Canadian Automobile Association, declared himself in favor of a Canadian transcontinental highway. "I have just returned from California," said Mr. Howland, "where I learned that they have spent $37,000,000 on good roads and intend to spend $20,000,000 more, but on account of better climatic conditions, they can build two miles of roads there for the cost of one mile here."

M. J. Overell, president of the Hamilton Automobile Club, said that the Toronto-Hamilton Highway is a good example of the benefit of good roads. It is already so popular that it is overcrowded. He hoped that the building of more roads like that highway would relieve the congestion there.

B. Michaud, of Quebec, presided at the morning session of the congress, Wednesday, May 8th. W. A. McLean, B. Michaud and S. L. Squire were unanimously elected as the members of the resolution and legislature committee.

Who Should Pay for the Roads?

In the absence of C. R. Wheelock, who had been scheduled to address the meeting on "Who Should Pay for the Roads?" Hugh Bertram, of Orangeville, Ont., who is a member of the Toronto-Hamilton Highway Commission, spoke on this subject. His address appears in full on page 438 of this issue.

The discussion on Mr. Bertram's speech was led by W. A. McLean, whose speech upon this subject is published on page 439 of this issue.

J. S. Sanderson, of Oxford Station, Ont.; James H. MacDonald, of Connecticut; and W. Findlay, of Ottawa, also took part in the discussion. Mr. Sanderson, who is president of the Dairymen's Association of Eastern Ontario, said that the people in the counties and townships believe that the federal and provincial governments should give more assistance in road building. He stated that the farmers are not satisfied with the help that the cities are extending, but that when the farmers feel that they have the city people earnestly behind them in the road movement, the farmers will become more enthusiastic.

Mr. MacDonald said that the eighteen years which he had spent as state highway commissioner of Connecticut, had shown him that the system of distributing the cost of roads which is being introduced in Ontario, is the only fair and satisfactory means of paying for roads. At the beginning of his commissionership, said Mr. MacDonald, his state spent $75,000 a year on roads. At present the average annual expenditure is $6,500,000.

Advocates High Types of Construction

Mr. Findlay, who is business manager of the Ottawa "Journal-Press" and also an alderman of the city of Ottawa, and who represented the Ottawa Motor Club, made a good speech on why and how the cities should assist in paying the cost of good roads. "The people are willing to pay for roads," said Mr. Findlay. "They will all help, notwithstanding where they come from,—country, city or town. We must raise sufficient money to build the roads of high types of construction. The state of New York lost millions by building roads that were too cheap. By means of automobile licenses and by direct votes of money, the cost of good roads can be secured."

At 11.35 a.m. the session was adjourned to give the delegates an opportunity to motor to the plant of the Sawyer-Massey Co., Limited, of Hamilton, where that firm's full line of road machinery was examined with much interest by the delegates.

(Continued on page 446)

ABATEMENT OF THE DUST NUISANCE*

By E. R. Gray
City Engineer, Hamilton, Ont.

THE abatement of the dust nuisance is a subject concerning which much has been written and in connection with which a considerable amount of valuable experimental work has been performed. The result of this study has been the establishment of certain well-recognized, standard principles in the application of the methods to which I shall refer. It is not my intention to deal with the subject in a formal way, but merely to outline something of our local experience.

The dust nuisance may, in varying degrees of efficiency, be dealt with by the following methods:—

(1) By removing the dust and loose material on the surface by the use of mechanical methods such as horse sweepers, scrapers, etc.

(2) By the application of a dust-layer in the form of (*a*) water from the ordinary sprinkler; (*b*) a deliquescent salt, such as calcium chloride, applied by hand; (*c*) a bituminous material, either as an asphaltic petroleum or a tar product (this method being the subject of this paper).

(3) By the construction of what is known as a dustless permanent road surface of some one of the many standard types (this, however, being outside of the scope of this discussion).

The application of any one of the above methods, or the combination of parts of each, depends upon the condition of the surface and the character of the roadway to be treated.

Horse sweeping, hand brooming and the removal of the dust by teams and wagons, does much to keep the roads free from the material which blows, after which the road may be further treated if it is so desired.

The second method, that of applying a dust-layer of some kind, is to-day perhaps the most generally adopted for dust abatement and road preservation. As ordinarily applied, however, this method is far from perfect, and we await with interest the discovery of some more effective and some less troublesome cure for the dust nuisance.

We easily see that road oiling has become a very efficient operation for dust prevention, but while we have tried many methods of varying our work here in Hamilton, I am free to say that as yet it has not developed that perfect state which you might be led to believe. The year before last we were using what is known as a light road oil. We were getting very good results from it, and in many cases were getting a pretty fair cover, and it was with the desire of securing a heavier cover that last year we used a quantity of medium road oil. You know what the season was like. It was cold and wet, and in fact we had to give up some of our oiling altogether because of the weather conditions. The oil being somewhat heavier than the oil that had been used in the previous seasons, we had much complaint from the people on the streets. We usually put screenings from our quarries on the oil after it has been distributed, but we found it impracticable to close our streets in order to keep the traffic off them for a sufficient length of time for the oil to harden. If we were doing a street at a time here and there, that might be arranged, but where we are doing miles of streets, and we have many miles of improved macadam roads in the city, it is not a feasible method of handling the situation.

Continued experiment over the past ten years has practically established the fact that the application of some kind of bituminous material to the surface of the road is the most efficacious method known to date. Salts, chiefly calcium chloride, have been used, but so far as I know these have never gone past the experimental stage or have been applicable only on small sections of road. Calcium chloride is obtained as a by-product in the manufacture of soda, and is distributed dry by sowing over the road surfact or spreading by shovel.

Calcium chloride is used in England to quite a large extent, the atmospheric conditions there lending themselves to the use of this particular material to a great deal better advantage than in this country. In fact, where it has been used here, around Boston, it was necessary, after the application, to water the roads in order to secure sufficient moisture to keep down the dust.

The salt, by its faculty of absorbingmoisture from the atmosphere, dampens the surrounding dust-layer, thereby reducing the tendency to blow.

An experiment of this character was carried out by the United States office of good roads, under the direction of Logan Walter Page, in Florida, by the application of 1½ pounds of chloride per square yard of surface. After several weeks of wear, the surface was always moist. No costs are given in connection with this method, so that comparison is impossible.

Holton Avenue, Hamilton, asphalt road oil on waterbound macadam. Photo at end of season, 1917

Inquiry as to the present price of calcium chloride in fairly large quantities shows that it is four cents a pound, so that for dust preventive purposes, on the present market prices, it is hardly an economic consideration.

The application of a bituminous material to the road surface is generally recognized as the method producing the most satisfactory results at an economic cost. The kinds of material used, and the different kinds of the same material, vary considerably. Certain principles, however, for the proper efficient use of these materials are outstanding if the best results are to be obtained.

The character of the road and the condition of the road surface are important considerations in deciding upon the particular treatment to be used.

It is generally conceded and results have proved, that as much of the loose material as is economically practicable should be removed from the surface of the road. I have read that under certain circumstances, some engineers have gone so far as to lightly sprinkle the road before the application of the oil, with the idea of removing

*Address delivered May 10th, 1918, at Canadian Good Roads Congress.

from the stone the thin film of dust which would prevent the proper adherence of the dust-layer to the macadam. I would think that was rather a dangerout procedure unless the road was given sufficient time to dry subsequent to the application of the oil.

Under such conditions, then, what is going to happen to this dust that lies on the road? It is going to be spread over the road, again, so it seems to me rather a superfluous procedure.

Any necessary repairs to the old macadam should be made in order to improve the conformation of the road, and provide for a free drainage to the gutter.

On country stone roads, where frequently the dust lies inches deep in layers, a horse sweeper could be used with great benefit and at very little added expense to remove this surface material to the side of the road, where it could be taken care of by different means, depending upon the environment. I have in mind many country roads where, regardless of the character of the surface of the road and the amount of dust and loose material on the road, the oil cart goes along and sprinkles the sand. It is only a short

Devonport Street, Hamilton, macadam treated with asphalt road oil in early Spring, 1917. Photo in Fall after season's traffic

time before that oil dust is blowing with every vehicle that passes, making the actual dust conditions much more disagreeable than the ordinary dry state of the dust.

Oiling performed after cleaning is much more effective, and I am of the opinion that the results warrant the small additional expense of such cleaning.

Having prepared the road surface, the next consideration is the character of the material which is to be used and the method of its application.

Asphaltic petroleums and tar products are the most common materials used for this purpose. Until recently they have been easily obtainable. They lend themselves readily to distribution, and prior to war prices were an economic material for this purpose.

The asphalt petroleum is sold commercially as a 40 per cent., 60 per cent. and 80 per cent. asphaltic oil, increasing in specific gravity in the order named. The tar products are sold under trade names which indicate varying degrees of specific gravity, the purchaser purchasing that particular product which is most suitable for his requirements.

Our experience in Hamilton has proved that what is known as a "light road oil" or a "medium road oil" for city work may be used with great effectiveness. In some cities a considerable lighter oil is used than the "light road oil," but this requires a more frequent application with a consequent increased cost.

Ordinarily, except under very heavy traffic, one application per season has been found to be sufficient of the 40 per cent. and 60 per cent. asphaltic petroleum. The lighter grades of oil may, however, be applied earlier in the season and without the necessity of heating in order to facilitate distribution. They are easily absorbed, dry out more quickly and reduce the dust nuisance during the late spring and early summer months. Light oils are applied also in smaller quantities than the heavier oils, as low as .085 gallons per square yard being found sufficient for good results. This is a very low figure. It is the Toronto figure. It is necessary to go over these roads two or three times a year, but they do away with that sticky condition which obtains in the use of heavier oils.

Oils are applied to road surface by several methods, depending upon the character of the road and the amount of oiling to be performed. In small communities it is sometimes distributed from the barrel by use of the ordinary hand sprinkling can. In such cases lighter oils are used and heating is obviated. In a larger way it is applied by gravity from tanks, either through a perforated pipe or nozzles specially adapted for the purpose, the oil being applied either hot or cold, depending upon its specific gravity.

Large motor-pressure distributors are now frequently used where the amount of work warrants it. This method of distribution being usually known as the penetration method. The material is applied hot, a heating device being used in conjunction with the distributor.

I have not the exact mileage of macadam in the city, but we have felt that we would not be justified in the purchase of a large distributing pressure sprinkler, for the reason that with our eight horse-drawn sprinklers, one in each district, we are able to cover so much more ground and are able to get our work done early in the season, earlier than if we were operating only one machine. We find, when we start oiling, that the people are very anxious to get their streets oiled, and it is a problem to know which street to oil first. We have had to make a rule that the streets with the greatest amount of traffic will be the streets that will first receive attention, regardless of how many friends a particular man has on any street, or how anxious they are to get their street oiled before their neighbors' street.

Much better results are obtained if the road surface is warm when the oil is applied, as diffusion through and over the surface then readily takes place before the oil congeals. This is especially applicable to the heavier bituminous materials. The surface should be free from moisture.

I was going to put it stronger and say it "must" be free from moisture. We have, however, been caught out in a rainstorm with a cart full of oil, and continued work. If the sun came out and dried things up quickly, it was not so bad. But we have had difficulty where the oiling was performed on damp surfaces, in getting proper drying and penetrating effect.

Heat is usually necessary in the application of the heavier road oils. In Hamilton, where last year and this year we are using a medium asphalt road oil, *i.e.*, an asphaltic oil which under certain conditions of test contains an average of 60 per cent. of the original asphaltic petroleum, the oil is first heated in large steel tanks by steam coils to a temperature of from 100 to 150 degrees, and pumped into ordinary oil carts, from which the oil is distributed by gravity on to the street.

The method of procedure is as follows: The street is first thoroughly swept by horse brooms and all the loose material that is practicable is cleaned from the surface of the street and removed. Oil, while hot, is then applied by a gravity sprinkler at the average rate of ⅛ gallon per square yard of road surface. Coarse rock screenings and stone dust are then distributed by hand over the surface of the oiled road in order more quickly to absorb the oil and prepare the road to receive traffic.

In calculating that figure of ⅛ of a gallon per square yard of road surface, we measured the road from curb to curb. The sprinkler does not sprinkle the whole width of the street, but the whole width is effectively oiled, in that a certain amount of the oil runs down the crown and effectively oils the portion next to the curb, so that I feel it is right and fair to consider that the whole road surface is oiled.

Ordinarily the street is not closed to traffic. Better results would be obtained here if the streets were closed from 24 to 36 hours after the oil application, in order to allow a certain amount of absorption and hardening of the oil to take place before traffic is allowed on the street. On busy city streets, however, this is hardly practicable.

When we are oiling up one street and down another, we would have a large section of the city completely ostracized from the rest of the town except by pedestrian traffic, and this would cause great inconvenience. We find it does not cause really serious difficulty to let the traffic go right over the street after it is oiled.

The amount of oil used depends altogether upon the character of the surface being treated and the extent of the coating desired. It varies from an eighth to a quarter of a gallon, and sometimes one-half gallon, per square yard.

I might say that last year in Hamilton a very accurate cost was kept in connection with street oiling as carried out in this city, the detailed statement of which was published in *The Canadian Engineer* for December 13th, 1917.

The average cost, without regard to overhead such as superintendence, engineering, repairs to plant, depreciation, insurance, etc., was \$.01673 per square yard, or \$1.673 per 100 square yards. This is equivalent to \$235 per mile of 24-foot roadway, or a little less than 2¼c. per lineal foot of frontage.

I was surprised when we began to figure up our overhead in connection with our road oiling proposition. Our repairs to our little pump at the yard where we have our tanks, the cost of steaming, heating, the repairs to our tanks, the depreciation, insurance, etc., amounted to 31 per cent. of our total cost. I went into that very carefully. I was thunderstruck, but that is what keeping costs tells us.

Ordinarily, unless costs are very carefully analyzed, and a knowledge of conditions obtained, the figures are apt to be misleading rather than instructive. They vary, depending upon the price of labor, material and the methods adopted, so that real efficiency must be judged on a basis of these considerations. The following base prices were applicable to the above costs:—

Teams per hour	\$ .75
Labor per hour	.35
Oil per gallon	.096
Screenings per ton	.85

The screenings were distributed by shovel from a wagon travelling slowly along the street.

CONCRETE ROADS*

By A. Lalonde, C.E.

Assistant Engineer, City of Outremont, P.Q.

WHEN a community decides to construct a road, the officials must find out first the amount of money available to pay for the initial cost; second, the amount of money available to pay for maintenance charges. The next step is to decide on the type of road which will best serve their purpose. Concrete will certainly be amongst the different types they will be called upon to consider.

In making a choice they have to bear in mind the essentials of the ideal road, which should be durable, sanitary and noiseless; thoroughly adapted to motor traffic; not slippery; and with low initial cost as well as low maintenance charges. Low maintenance naturally means easy repairs.

Data regarding the age and durability of the various concrete pavements, together with the future maintenance cost per year, are not yet established on a very sound basis, though the figures at hand are reliable enough for the sake of comparison. That is not the case with water-bound macadam, bituminous macadam or similar types. A considerable mileage of these roads have been laid during quite a number of years and accurate data kept on same.

The sanitary and noiseless state of a road especially applies to city pavements.

Motor vehicle traffic has come with us to stay. Humanity will profit by it, possibly more than it did with steam and electric transportation. It is the writer's opinion that we ought to take the difficulty as it stands, and not put out any law or any restrictions that would hamper the growth of that kind of transportation. If our roads are not fit for the new work, let us build roads that will stand this kind of traffic as well as other kinds.

Slipperiness should be dealt with very closely in Canada on account of our fall and spring conditions.

The demand throughout Canada to-day is for a long mileage of low-cost roads, but there is quite a difference between this statement and the belief so strongly entrenched in our different provinces that every time we ought to choose the cheapest road. It is an established fact that maintenance cost is much lower on hard surface roads than on any other types. The gross annual cost per square yard, which includes interest on initial cost, plus amortization, plus annual repairs, on different pavements, are, according to E. W. Sterns, chief engineer of highways, Borough of Manhattan, New York, as follows:—

Concrete	7.8 cts.
Asphaltic concrete on 6-inch base	11.0 "
Sheet asphalt on 6-inch concrete base	11.25 "
Brick on 6-inch concrete base	14.00 "
Bituminous macadam	15.70 "
Asphalt block	16.90 "
Water-bound macadam	17.75 "
Wood blocks	20.40 "
Granite blocks	21.00 "

Concrete roads will fulfill nearly all the above requirements of the ideal road. Though there are no very old concrete pavements in existence done under the present practice, the present condition of those which have stood quite a few years of service would be enough to satisfy

*Address delivered May 9th, 1918, at Canadian Good Roads Congress.

anyone who may doubt their durability. They offer very little resistance to traffic; they produce practically no dust and may be easily cleaned; they are not too slippery; and they are thoroughly adapted to motor traffic if well maintained. They can be constructed at a reasonable cost; as a matter of fact, I think they are the cheapest of all hard surface roads. It may also be noted

Livestock is Transported by Motor Truck Over Concrete Roads

that when considerably worn down by traffic they may be used as a very sound base for asphaltic concrete, sheet asphalt, brick or wood blocks pavement. They can be maintained at very small cost.

On the other hand, they are quite noisy, but this disadvantage should not be taken into account in the case of rural roads.

There is no method, to my knowledge, to prevent wear in the vicinity of joints. Cracks may appear even in places where joints are well constructed. Regarding difficulty in repairing, this objection is a valid one, but, sooner or later, will be found an easy method of making a first-class patch. Until then it would not be advisable to construct concrete pavements in a rapidly growing community if numerous street cuts are to be made in the surface.

There have been many pavements constructed with inferior materials, which accounts for a good deal of defective concrete pavement in Canada as well as in the United States. Only concrete materials of first-class quality for paving purposes should be used. The possible sources of supply of these materials are not quite developed and data regarding same are most generally not available. The investigations and reports made under the supervision of L. Reinecke, of the Geological Survey, will be of great help to road-builders in this country.

Any successful road requires a good deal of care as to details, and this is more true of concrete pavements than of any other. Cement is a wonderful material, but it has to be used properly. After a specification is adopted and the contract made, its terms and requirements should be followed rigidly. Some of these requirements may seem exaggerated to those paving contractors who do not understand their own interest. Often the engineer's or inspector's views are then overruled and the result is inferior construction. The inspectors should be very familiar with the specifications used and must look upon them as their reference library.

The specification of the Canadian Society of Civil Engineers for cement is commonly used. Good care should be taken that cement be stored in a dry shed where water will not leak through the roof or the walls.

Sand should be carefully chosen on account of being the controlling factor in the wearing properties of the surface. It should be free from clay, loam and vegetable matter. Careful instructions should be given to laborers shovelling same into wheelbarrows, that they do not shovel part of the soil on which the sand is deposited. Sand, the grains of which have natural coatings of limonite or other foreign matter, make a very friable mortar. So far as possible only washed sand ought to be used.

The coarse aggregate being called upon to take the wear and tear of the road, it should be hard, tough and durable. Its hardness should be at least equal to that of the mortar used. It must also be remembered that it has to sustain the shattering effects of the steel-shod traffic. So all soft stones, slates, shales and some limestones, etc., should be rejected. It should, of course, be clear of lumps of clay, pieces of wood and scales from uncleaned wheelbarrows. The presence of such matter will, sooner or later, produce local pitting and an increased wear on the surface. Long, flat stones should be picked up, first, because they produce scaling, and also they are very likely to come out, sooner or later, and leave a bad hole.

It is not a good policy to use crusher-run stone or pit-run gravel. These materials will not give to the concrete pavement the required uniformity of texture and hardness of surface. The dust which they contain in quite a large quantity will retard the hardening of the cement. These materials should be screened and separated into fine and coarse aggregates, even if it adds a certain amount to the cost of the work.

When building a two-course pavement the bottom course aggregate may be softer than in the one-course construction, but, on the other hand, the wearing, or top course, must be richer in cement than the one-course. The maximum size of aggregate should be smaller than the one-course, and also harder. To quote Messrs. Agg and McCulloch in their "Investigation on Concrete Roadways" for the Iowa State Commission:—

The Construction of Concrete Roads Brings New Business to the Truck Salesmen

"The life of a concrete pavement depends to a large degree, on the correctness and uniformity in the proportioning of the materials. Emphasis should be laid on the fact that the present methods of field proportioning are exceedingly crude. The development of the bituminous pavement surface has been characterized by the adoption of accurate methods of proportioning and grading the materials. Concrete as a surfacing material will never be used at its highest efficiency until the proportions are specified by weight, and these pro-

portions accurately maintained as the materials are placed in the mixer."

I would like now to say a few words regarding the general construction. Heavy stress should be laid on the making of subgrade and drainage. Unequal settlements should be avoided. No concrete should be laid over fills which are not thoroughly compacted or have not yet attained their ultimate settlement, which takes place at the end of about one year. A flat subgrade gives more concrete in the centre, where it is most needed, though one that is shaped to conform with the finished surface takes less concrete and gives better drainage. The subgrade should be rolled and reshaped until it has the specified shape and uniform firmness. This will not only prevent waste of concrete, but will also facilitate the movement of the pavement due to contraction and expansion, and, therefore, prevent the formation of cracks. It is a well-known fact that a rough and uneven subgrade renders the transverse joints about useless.

The system of drainage should be carefully studied and planned. It should not only take care of surface and underground waters, but provision should also be made for temporary drainage, so as to prevent the washing of green concrete by surface water. Such occurrences often necessitate the tearing up and removing of the entire pavement slab. The problem is to keep the subgrade dry by using the different resources or materials available. Were it not possible to do so, the design of the pavement, for such a length as may be found necessary, should be changed. In a poorly-drained subgrade there is a tendency for the edges to dry out quicker than the centre, with a consequent settlement and production of longitudinal cracks in the pavement surface, especially when the cold sets in or goes out of the ground. Nearly all engineers to-day are of the opinion that the unsightly cracks that one may notice in many concrete pavements are due to a very great extent to poor drainage.

Finishing

General practice seems to favor the wooden float for finishing. If handled by a skilled workman, it will give

Another Prettily Located Concrete Road Near Winnipeg that is Popular Among the Motorists

a satisfactory surface, sufficiently rough for all ordinary grades. The thinnest possible skin coat of cement should be brought to the surface so as not to cause scaling. Over-floating not only costs more money to the contractor, but does not give so good a surface.

It must be borne in mind that after concrete is deposited and floating done, the pavement is not finished. Good care should be taken that green concrete is not exposed to the hot rays of the sun. Canvas should be kept over the green concrete for about twenty-four hours, after which it can be sprinkled. No empty cement sacks should be allowed on the green concrete. Dirt can be used at the end of forty-eight hours, and should be kept wet for ten days. These precautions, if they are not overlooked,

Fort Garry Drive, Crossing Point Road, Near Winnipeg. Two of Manitoba's Oldest Concrete Roads

will prevent shrinkage cracks and conserve water, which will be needed for the chemical combination of the cement. Curing by ponding is also a very excellent method. The inspectors should see that all the dirt is completely removed and the surface well cleaned before the road is opened to traffic. As to the time of opening such roads to traffic, I would quote the following extract from the "National Conference on Concrete Roads for 1916":—

"The length of time necessary to keep the pavement closed to traffic will depend entirely upon weather conditions. During warm weather the pavement should be kept closed to traffic for at least fourteen days and preferably for three weeks. When the conditions are such that the temperature of concrete is less than 50° when placed, hardening takes place very slowly. As is well known, the hardening of concrete is a chemical action requiring heat. The hardening will take place in direct proportion to the amount of heat present, and takes place very slowly at a temperature of 35° Fahrenheit or below.

"When a concrete pavement has been laid in the late fall, it is sometimes difficult to determine when it will be safe to throw the road open to traffic. In rare cases it may be necessary, owing to peculiar local conditions, to open the road or street to traffic before it is absolutely safe to do so. Under such conditions, if about 3 inches of straw be placed on the pavement and this covered with several inches of earth, the surface of the pavement will be protected sufficiently against abrasion to allow the opening of the road sooner than could be safely done without such protection. This cover will, however, not minimize the danger of damage to the pavement by heavy loads, which will tend to crack pavement that has not developed its full strength. Concrete roads have been utterly ruined by opening to traffic too soon. Few people realize how slowly concrete hardens under unfavorable conditions, which will undoubtedly prevail on some jobs before the work is finished. All those in charge of concrete pavement work should have the necessity of adhering to the foregoing cold weather precautions strongly impressed upon them."

The recommended practice for transverse joints is that joints should be placed across the pavement, perpendicular to the centre line, about 50 feet apart. There seems to be a tendency to lengthen the distance between joints, and even to eliminate same entirely. Many en-

gineers advocate to-day the placing of a transverse joint only at the end of each day's work. The difference in the kinds of soil over which the pavement is laid should not be overlooked. A good practice, when metal protection plates are used, is to finish the pavement at least six inches on each side of the joint with the steel trowel. Though considerable difference of opinion exists as to the use of such protection plates, it seems that the present practice has much tendency to do away with them.

Many of the unsightly longitudinal cracks will be done away with in concrete roads if precautions have been taken to ensure a thorough sub-drainage and a uniform subgrade. Longitudinal cracks are the worst enemy of concrete roads. It has not yet been proved by any plain concrete road that they can be eliminated altogether, but with the refinement of the present practice in the construction of such roads, they will be reduced to a minimum. The use of reinforcement will eliminate to quite an extent the formation of longitudinal cracks, or at least will render them less objectionable. Mesh reinforcement is much easier to place than bar reinforcement. Reinforcing depends on the condition of soils and loads, and it is a matter that certainly should be left to each engineer to determine on the spot the needs of the situation, after having well weighed all the circumstances Some engineers are of the belief that the use of reinforcing will ensure stability to the road, scatter shrinkage cracks and eliminate joints.

Regarding the thin, bituminous wearing surface for concrete pavements, the results obtained to date do not economically justify its use just at present. Maintenance of concrete pavements will be greatly simplified so soon as a satisfactory method of coating their surface can be devised.

After the road is completed and opened to traffic, it has to be maintained, and this is a point that should be clearly demonstrated to the officials of all communities who are planning good roads. An efficient, systematic and intelligent system of maintenance should be devised and enforced. I do not need to show here the full economic value of such a system. No municipality, province or country will ever realize the benefit and merit of a good road unless it is properly maintained. While the cost of systematic maintenance of concrete pavements is small, if we neglect to maintain same the cost may be very high and the taxpayer will not have received the greatest value for his money.

When an engineer makes the statement that a concrete road represents the minimum outlay for maintenance cost, highway officials should not derive from these words that when a concrete road is finished no care or attention whatever need be given to it. This would be a very grave mistake. It is inherent to human nature that everything will wear away in the course of time, and it is so with all pavements, even though they be called "permanent."

In their ninth annual report, the Board of County Road Commissioners of Wayne County, Michigan, say:—

"Recognizing that durability and low cost of maintenance, as mentioned in preceding reports, largely determine the success of any type of road, our preference, based on our past seven years' experience, continues to be for concrete construction. We believe in constant and systematic maintenance of all roads under our jurisdiction. As in past years, our gravel and macadam mileage continue to absorb the bulk of our maintenance moneys and energies. We have repaired and oiled all gravel roads and in addition thereto dragged them systematically in both the spring and fall.

"The wisdom of building of concrete, in our judgment, stands out conspicuously when maintenance cost involved in keeping all other types of roads under our jurisdiction in usable condition is compared with the actual cost of maintaining concrete. Yet, even the best concrete road will require some maintenance, consisting principally of cleaning out and refilling expansion joints, the repair of pockets which occasionally appear on the surface as a result of some foreign material such as clay getting into the concrete, some fragment of inferior pebble or stone, or defects in workmanship. Usually no maintenance is required on our concrete roads the first year of their life, but if we find that any is necessary, we do it promptly and thoroughly.

"Our concrete roads possess the special feature of presenting a surface that wears but slightly and uniformly; a surface that does not give away in any one spot and withstands traffic over its entire surface. This is made possible by careful selection of materials, careful methods of proportioning and mixing, and care in finishing and curing, resulting in a concrete having an uniform texture, which is a big factor in eliminating maintenance costs. We have over 125 miles of concrete road in Wayne County, some of it in its seventh year of service, all of it in good condition, and we have never taken up and replaced a 25-foot section since we have been building and developing this type of road, which, we think, speaks volumes for our low annual maintenance costs."

NEW TRAFFIC MAKES ROAD CONSTRUCTION AN EVER-CHANGING SUBJECT*

By W. A. McLean
Deputy Minister of Highways, Ontario

ROADS are as ancient as human history. I suppose that in the olden days the Greeks and the Romans must have had their congresses to create public feeling and interest in those organizations which were required by them to construct the ancient highways that are still so famous. And if roads are so old and highway conventions are so old, the question naturally occurs to us, why are we still talking about them? Haven't we reached the point when we should have good roads without talking about them? The answer is that history repeats itself, and that while roads are old, human nature is the same and we must all learn our own lesson painfully, slowly and patiently.

While roads are old and human nature is old, men are new. We are constantly in a new generation. Changes are constantly taking place. While there is nothing new under the sun, yet the combinations of the old things are infinite, and as we go on year by year, there are new combinations of vehicles and traffic which we all have to learn. If we could see three or four more thousand years into the future, we would still see road conventions and congresses just as we have them to-day, to create the organization which will be necessary to extend and build highways for a constantly changing state of circumstances.

We to-day have entered upon a situation of remarkable combinations. Until a short time ago we had to construct roads only for the horse-drawn traffic. We have suddenly sprung into an age when the gasoline engine is applied to traffic and transportation and only the highway engineer who has considered the problem of the new motor vehicle can understand and appreciate the intricacies of the question that is before us. We have not only had to construct for the present state of circumstances, but we have to see beyond the sky line and construct for the future. We have to create in our imagination that toward which we are tending, and if we are to leave a heritage for the future that will be for their good instead of for their injury, we

*Address delivered May 7th, 1918, at Canadian Good Roads Congress.

must see that our financial methods and our schemes of construction are such as will apply to the future as well as give to ourselves the pleasure of good roads.

Hamilton, from a geographical standpoint, is one of the most important hubs of highway traffic that we have in Canada. From Hamilton radiates the road to Toronto, the Toronto-Hamilton highway, and on through to Montreal; the road to Guelph and Owen Sound; the road to Galt, Kitchener and Stratford; the old Governor's Road straight to Paris, and beyond, the older provincial roads through Ancaster to Bradford and Woodstock; the road to Caledonia and Hagersville, where it joins the old Talbot Road; and the road to Stony Creek and Niagara. These are all old highways, laid out as direct roads in the early history of Ontario, and they all join here in Hamilton.

Highways in war time are a much-discussed problem. But war itself in Europe to-day is largely a problem of roads, roads leading up to the front lines bringing up supplies, and roads upon which to retire and save under certain circumstances the material and men which man the front trenches. It is a problem of roads all the time.

The past winter has shown us that to sustain these men overseas, we have our own highway problem and that of the steam roads behind them. The steam roads here are fed by the highways. Close the highways, the common roads, and all our steam roads would stand in idleness. The war, our men at the front, would cease to be sustained. The answer to me is a simple one. Good roads are a matter of efficiency in time of peace and they are as much a matter of efficiency in time of war as in peace, and they are more necessary in time of war than in time of peace because it is the time when every channel of commerce should be in its most efficient state.

I do not think that this is the time to undertake great plans of construction. It is impossible, unfortunately, even for our modest efforts to obtain the men we need. Our highway department would do much more if we could only get the men, and we have to move cautiously so that we will not disturb the essential functions of production. But while it is not a time to undertake great schemes of construction, it is a time when what we have should be maintained in the best possible state of repair. By careful management (and if we have the ideal scheme of conscription throughout Canada, turning each man to the point at which he could do the most for the country, to win the war), we would have the men to maintain our highways, with a small amount of time, so that there should not be a great deal of wasted time and effort in travelling over those highways.

That is always an answer to why we want good highways. We concentrate into their construction and repair what is a small amount of time and effort in order that we may conserve and develop a great deal of time. But we have something more to do. We cannot at home rest satisfied simply with seeking to secure a military success in France. We have every thought of winning the war, but we have to meet the necessity of being able to throw in the clutch as soon as the war is over, to sustain and maintain what we have, and to do justice to the men overseas who will return. We must prepare for the time of peace and for the time of reconstruction after the war, in order that as a country we may not sink beneath the load of taxation that will be thrust on every country in the world.

I am sure that in what follows this opening session, the practical questions of road construction will come under discussion, and I hope that the policy which Ontario has initiated will receive its full share of discussion. Ontario has sought to organize and prepare for after-the-war conditions. Ontario has sought to do what it can, under the stress of war, in taking care of the upkeep of her highways.

HIGHWAY WIDTHS*

By F. Howard Annes, Whitby, Ont.

WITH the passing this week of the by-law covering the agreement between the government and the town of Whitby, Ontario, as to allotment of the Kingston Road through that municipality to be maintained by each party, a stretch of some sixty miles (or as far east from Toronto as Port Hope) on this historic highway comes under the control of the Ontario Highways Department for development as the initial unit and an integral part of the projected system of provincial highways. It is, therefore, proper to consider the practical phases of the great problem offered for solution in this splendid enterprise upon which the people of Ontario are entering. One of prime importance is the width of the road allowance. At present the standard is 66 feet.

A careful analysis of present requirements in width of road allowance for a trunk highway like the Kingston Road discloses pitiable shortcomings. A fair apportionment of 66 feet between actual road surface, ditches and a place on either side of the road for telegraph, telephone and electric light and power lines, leaves nothing but butchering of trees planted along the boundaries between private properties and the public road. Nor does the 66-ft. width take any account of future demands for wider road surfaces on an artery for motor traffic that possibly is unique in that it is the only highway serving the most populous and wealthy portion of Canada—Toronto, Montreal, Ottawa and the intervening communities, aggregating more than a quarter of Canada's population, and perhaps one-third of her industrial and mercantile establishments—a portion of this great and growing country that never can have any other road than this for intercommunicating by means of vehicular traffic.

Is it wise, when now it is wholly practicable to widen this road sufficiently to provide for the indefinite future, that any chances should be taken in erring on the narrow side rather than provision based on a broad and enlightened outlook for the years to come? The opinion now is held by governmental authorities that the only certain way of fighting the fuel famine in this part of Canada is to plant trees on every available acre. Is there any more encouraging step in this direction that the government of the province could take, than to plant a line of trees on either side at the street boundary of a system of provincial highways?

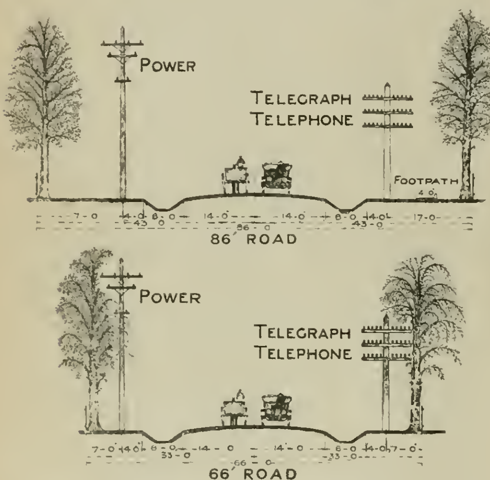
While these are some of the practical reasons for wider highways, there is the consideration of the æsthetic that is no less important. The element of width in a roadway is undoubtedly the one which most adds dignity and impressiveness. That is evidenced everywhere throughout the world in civic improvements by avenues, parkways, gores and other widenings of public roads. With the rigidity that comes to great centres of population in regard to such widening, it is only provident to prepare for a doubling or trebling of the population of this province already predicted by eminent public men.

What would Toronto not give if she could but widen Yonge and King Streets? The exact width of a new road

*Address delivered May 8th, 1918, at Canadian Good Roads Congress.

of this kind, fortunately, is yet to be determined. Already the principle is recognized in the Whitney Memorial Highway, running from Ottawa to Morrisburg, the native town of the distinguished statesman who best, and thus very fittingly, will be remembered as the man who made possible a road for electric current to be distributed all over Ontario under municipal ownership, and who, through his prescience and persistence, worked out the province-wide scheme since associated more with the name and fame of its successful protagonist, Sir Adam Beck. Adding ten feet to each side of a 66-foot road makes 86 feet, the width adopted for the Whitney Highway. My own idea is that, at least for the Kingston Road and its extension to Montreal, one hundred feet is better. That is the standard width adopted by the steam railways for a right-of-way. It means but seven feet more on each side, but will the more fully meet every need.

No name as yet has been proposed for this system of provincial highways. Why not one associated with



Sketch Showing Location of Trees and Pole Lines on Ontario Provincial Highways

the glory that has come to the sons of Ontario who sleep beneath the soil of France and Flanders? With triumphal arches at the Windsor, Niagara Falls and Montreal ends of the 500-mile trunk of the system, and at the entrance to the large cities, such a road system might well be made the finest memorial in the world. Is anything too good for those who have made the supreme sacrifice that civilization might not be destroyed?

Here is a suggestion for this purpose in devoting the provincial highways to the everlasting memory of those who have fallen fighting for us on the sainted soil of France:—

"ONTARIO GLORY ROADS, given, through their government, by the grateful people of that province, in honor of its sons, the Heroes of Canada, who freely gave man's greatest gift, Life, that liberty, freedom and justice might not perish throughout the world."

The New Westminster utilities' estimates for 1918 include: Light department, $37,246; water department, $17,462; board of works, $44,428.

WHO SHOULD PAY FOR THE ROADS?*

By **Hugh Bertram**
Member Toronto-Hamilton Highway Commission

IN trying to answer this question, one must first consider the service that roads in general give to the citizens of the country through which they pass.

Good schools and good roads are among a country's first and greatest assets, and, just as we find in the former the foundation of the educational and business life of the country, so do we find in the latter the foundation of the transportation system, which on this continent has had such far-reaching civilizing influences and has been the means of great development in a short space of time.

I mention schools purposely, for the one is handmaiden to the other, but until a common education became compulsory and free to one and all in a general way, we did not make the progress as a nation that we have since made, and not until toll roads were abolished did the people realize what it really meant to the general prosperity of the country to have roads free to be used by the rich and by the poor alike, with equal rights thereon. But the free use of roads by all who may or do use them, like freedom in many other things, as we know to our sorrow to-day, entails an expenditure that we must consider and be prepared to pay if we are to continue to enjoy them and receive the full benefit therefrom. It is here that the question thrusts itself before us, "Who should pay for the roads?" A simple answer would be the people, for they it is who in the end must pay. There are, however, various channels through which they can be reached without the expense being unduly burdensome on anyone.

First of all, I would mention the Federal Government which, in the past, has given such large sums of money toward developing the transportation system of our country as represented by railways, canals and waterways, but so little toward helping with the building of our roads, which after all is the real foundation on which the transportation system of our country must stand, and which has proven to be (next to man power) perhaps the most vital factor in the war. It may have been necessary in a country of such distances to have given the millions that have been given to the railways, but there is no reason why the roads should have come in for so little attention as has been given by the Federal Government. However, the time has now arrived when it becomes imperative to give some aid to the roads, the people's roads, in order that they may be able to sustain the transportation superstructure that we are now called upon the carry; for three years of war has shown the limitations of railways and the great possibilities of road transportation.

Federal aid should be given with the view of helping in the construction and maintenance of some of the main roads between cities, towns and market centres, relieving the municipalities interested to an extent that would allow them to devote more attention to the ordinary roads. The same argument holds good regarding aid from the provincial government, for while admitting that they are already assisting, there still remains very much that they could do, which would not alone be a helpful benefit to the municipalities, but would act as an impetus for them to make greater efforts to lift the outlying roads to a higher standard.

It is here probably that we should mention the amount collected from the automobile licenses by the provincial

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*Address delivered May 8th, 1918, at Canadian Good Roads Congress.

government. By many it is thought that this money rightly belongs to the roads, irrespective of any grants the province may make, being a tax supposedly for injury done, and as such properly returnable to the roads. This seems to be an ever-increasing source of revenue, and should help materially in the betterment of the roads if used for that purpose.

To this should also be added fees that may be collected from motor vehicles doing a freight or passenger business on any of our improved roads. Until very recently the cities have given little or no assistance to the roads outside of their own boundaries. However, it is recognized now by the government and by most cities that giving assistance towards the betterment of the roads lying adjacent to the city, not only facilitates transportation but brings the producer and consumer closer together to their mutual benefit; for this reason, cities should bear a share of the cost of the building and up-keep of those roads. In Ontario we find that nearly all the counties have now joined the good roads system, allowing them to partake of the provincial government grants. When roads are built to a certain standard, this is good so far as it goes, but there still remains a rather heavy burden for the ratepayers when we consider that they have to pay not only their share of county taxes for road purposes but must keep up all township roads as well.

I might mention here that most counties in going into the good roads system map out a program of road-building that requires considerable money. This is generally raised by a bond issue.

In the past, many counties have made the mistake of issuing bonds for too long a period, the roads being worn out before the bonds were retired. In issuing bonds for work of this nature, the maturity of the bonds should fall within the life of the improvement, thus insuring the taxpayer's value for money expended.

In the township roads we find the source of the major portion of rural traffic. They are without a doubt the most neglected part of the whole road system and yet the most important. At the present time the statute labor tax is the only source of revenue for this work unless a grant be made out of the general taxes. The township road system is so extensive that the statute labor tax is totally inadequate in most townships to keep the roads up to a proper standard. It is here that I contend the effects of federal aid would be felt most, for, in assisting with the building and maintenance of the main travelled highway, it would allow the provinces and the counties to give some much-needed aid to the townships' roads. When we stop to consider conditions as they exist to-day and as they are likely to exist after the war in regard to urban and rural population, it goes without saying that after-war conditions will find the cities and towns over-manned and the rural districts under-manned. One of the great problems will be to get the people back to the land, for our national recuperative powers will be largely governed by the manner in which we develop our natural resources.

The British premier, David Lloyd George, said in one of his great speeches, that never again would the farmers' interests be neglected as they had been in the past; so let us try to remember that neglected roads means jeopardizing the farming industry, the most essential industry in our country. While I would not go so far as to say that bad roads have been the cause of the depopulating of rural Ontario, I will say that it is one of the causes, just as I would say that good roads, and the benefits accruing therefrom, will prove to be one of the remedies for the repopulating of the rural districts.

There are some people who believe that where a more or less permanent road is built, thereby increasing the value of the property fronting it or adjacent to it, it should bear a part of the cost of the road. This is a debatable point, many believing that where a road has increased the value of adjoining property and increased the assessment (which in turn meant increased taxes on such property for all purposes), if the municipality as a whole benefit by the increased assessment and taxes, it should assume at least a part of any frontage tax that may be levied.

In conclusion let me say if we could only unite those different interests I have mentioned in a carefully-thought-out scheme for the betterment of our roads as a post-bellum measure, it would not only create a valuable asset to our country,—one that would bear interest in the progress and prosperity that would surely follow,—but it would be one sure way of providing useful employment for those who might need it in the period of readjustment which will no doubt follow after peace has been proclaimed.

WHO SHOULD PAY FOR THE ROADS?*

By W. A. McLean
Deputy Minister of Highways, Ontario

THE problem of paying for the roads is one to which naturally I have given some attention,—perhaps more to that phase of the subject than to any other. There is one thing that we may accept right at the outset, and it is no use blinding ourselves to any other phase or any other complexion of the situation: Roads must be paid for.

Through Spain and the southern countries of Europe, there are remains to-day of the old roads constructed centuries ago under the Roman Empire. The somewhat superstitious peasantry of those countries, having no information and no historical knowledge of how they were made, have the impression that they were a gift of the gods, created by some supernatural power. I am afraid that there are still people who have the idea that roads can be constructed in some such way.

I believe in the efficacy of prayer and I say it solemnly, but I have yet to find the road that has been constructed solely through the medium of prayer. It means work; it means material; and these have to be paid for, and the people of this country will have to pay. Now, there is no use saying that the Dominion government should give to this work, the province should give, some other organization should give. If they give it they must obtain it from the public, from the people, before they can give. There is no tap extending up to Heaven that the commissioners can turn on and expect the ducats to flow from any other source except the people. There is the fact we must face that the people of this country must pay for the roads. The only problem is to distribute that cost in an equitable manner, one which can reach the results without placing any excessive burden on the people.

In order to do that we must remember that road construction is a slow process. We cannot lay out a system to-day and employ an army on it and before the end of the year see a great completed system of highways throughout Canada. The Toronto-Hamilton highway was undertaken with every good purpose, was carried out as

*Address delivered May 8th, 1918, at Canadian Good Roads Congress, as discussion of Mr. Bertram's paper of the same title (see page 438).

efficiently as honest and sincere commissioners could be expected to carry it out, and with all possible speed, and yet in order to reasonably construct it, and part of it is not quite complete, it took three years from the time it was started to construct thirty-six miles of paved highway.

Our problem is not one which should discourage us. It looks to be a tremendous thing when we think of the extensive mileage that we have through Canada, some 250,000 miles of highways in the Dominion of Canada to-day. We should not let that problem discourage us. It is a slow process. The roads must be constructed by manual effort and can only be financed by an annual measure, so that when we start to construct a system of highways we don't have to have the entire sum in our pockets. We appropriate our money year by year for this purpose, and considering the time it will take and the means we have at our disposal, I am of the opinion that the people of this country are amply able to pay for and to construct a system of highways in every way adequate to our requirements, without any serious financial struggle.

Not a Shortage of Money

With us to-day, in order to carry out a good and adequate plan of construction for this year, we are not held up because the province has not the money, nor the county. I have yet to see the county that has not the means available to carry on a satisfactory scheme of construction this year, and certainly the province is not holding up because we have not the means. It is because, as you know, the men are not available. They are, perhaps, in a few localities, but throughout Ontario and Canada as a whole, the work is simply delayed because we know it is not expedient to undertake any great system of construction and so enter into competition with the labor market that is at the present time strained in order to take care of the essential, the most essential matters that we have in hand.

I have said that we should all pay for the roads. We must all pay for the roads. One serious situation that we have discovered in Ontario, and I think it pertains throughout Canada, is that in the past the farmers, the rural sections, have been expected to construct highways solely at their own expense.

Now we find that the townships are fairly well assessing themselves (not so much as they can, not as much as they will do) for ordinary township road purposes, but they have not had the means of setting apart, until the province took hold of this matter, a special system of highways on which to concentrate effort.

Suburban Road Systems

In order to separate the main arteries, the more important market highways, into a class which would receive immediate attention, the province established a scheme of county roads upon which the people of the townships, through the medium of their county councils, should concentrate their efforts. But we were still met with the serious condition of which I have spoken, that only the people within the county organization were called upon to pay for this work. And although these highways go right up to the entrance to the cities, although cities in every other country are helping to maintain and pay for such main arteries, through our scheme of municipal organization the cities were escaping entirely.

In Ontario we have established a plan of having suburban road systems. This creates somewhat of an offshoot from the city council and the county council, on which each are equally represented. A certain mileage of roads is selected adjacent to each of the cities, and on these the city and the county unite their efforts in what I would call the metropolitan area surrounding each city, and just as the province aids the county or gives its contribution to the county, so it is extended to the suburban area, with the result that within the suburban areas the province estimates that it will contribute twice as much to the roads within those areas as to the ordinary county roads. The cities will join equally with the counties which makes the associated townships. That is, we have established a plan by which the cities can co-operate in constructing the more heavily travelled of the country roads, and it is an axiom of road construction that roads must be constructed and maintained and consequently paid for practically in proportion to the amount of traffic over them.

It has been said that the province should give more than the fees from automobiles. I have no doubt whatever that the province, so soon as it finds that the available funds from automobiles are absorbed through the channels that have been established, will find other means of supplementing that expenditure sufficiently to meet the needs of our annual plan or scheme of construction. Ontario has accomplished a good deal in road construction. I have talked with quite a few from the United States and elsewhere who have been on our highways. I have been over quite a few highways in the United States. I have seen highways much more expensively built than any we have here, but I have taken as much comfort out of our own particular type of highway as I have out of some of the more expensive types, for the reason, after all, that maintenance is the only permanent part of any highway and some of those expensive highways are not properly maintained and certainly are some of the most uncomfortable highways one can drive over.

A Few Main Arteries Urgently Needed

Cheaply constructed highways, where traffic is not heavy, will serve every purpose if they are maintained. As traffic increases, the highways should be constructed in proportion, and maintained in proportion, and consequently the area of payment must be extended, and so we extend it to the county and the province joins in. A considerable proportion of the counties have for some time been constructing their market roads with excellent results.

What Ontario needs more than anything else is a few main arteries in order to develop what we have. You know that you can get from Hamilton in reasonable comfort over quite a series of old county roads. Close to Hamilton these roads are worse and in poorer shape than they are some miles out. Why? Because they are not a strong enough type to support the heavier traffic concentrating itself close to the larger centre of population, entering the city of Hamilton or going out from the city of Hamilton. As you leave the hub the traffic diffuses itself and in a remarkably short area it is astonishing how you will pass from the section in which expensively constructed highways are required, to the area where comparatively cheap roads will serve the traffic equally well.

But, as I have said, what we need are certain main arteries, and we are planing for them. What I have said as to the diffusion of traffic hardly applies to those main arteries, because the traffic there is from city to city and town to town and is fairly well concentrated between important terminal points. The province has created an organization for a provincial system of highways. We have started that organization, have taken over a section from Toronto to Port Hope, and it will be extended as fast as it seems expedient. When such a system of con-

nected roads exist,—that is, when the main highways, a series of sections connecting up the county roads, are constructed,—when these main arteries are constructed, I promise you that in Ontario we will have a system of highways that will be equal to any on this continent, because we will be able to go from one end of Ontario to the other, get out on the county roads constructed by the counties, carrying the market traffic, and from those to pass onto the township roads, maintained at the expense of the township, but upon which they will be able, after the county has created its system, to concentrate all of their efforts.

The average township road, under favorable circumstances of material, can be maintained in very good condition with the ordinary township expenditure, and the townships can carry their own financial burden. The county roads require a heavier expenditure of funds. For the present the township, the county and the province will have all that their financial effort will perhaps enable them to meet. But here you have a scheme of distributing the cost. The city joins in the area of the county, and the township looks after minor roadways or arteries. By minor arteries I mean such roads as have perhaps ten or twelve vehicles a day. Such roads require comparatively light construction. When you get up to 25 and 50 or 100 a day, according to circumstances, or 200, 300 or 500, you have to extend your type of construction and spread the cost over the people.

Roads as Costly as Railways

The question of drawing the cities together is the main point to-day. I sometimes illustrate the equity of it by saying we cannot have the county road pass every farm and yet the farmer on the township road has to pay for his share of the construction of that county road, because he drives two or three miles, gets on it and goes to his market point or into the city.

In the city you have an area of two, three or six thousand acres, with a population of ten, twenty or a hundred thousand. Why should that area and population escape from the cost of those main arteries that serve the country any more than the farmer whose property is not even on the county road? In the city you have an area and a population, in the individual farm you have an area and population, they are all part of the country.

Roads, main arteries, cost as much to construct and proportionately to maintain as the steam railway does. A good main artery costs fifteen, twenty or thirty thousand dollars per mile to construct. That is what the steam railway costs. It is an expensive undertaking. Everyone must share in the cost in Canada, as they are sharing in the United States, as they have shared in the past in England and in France. I have always held the view in Ontario that until the cities and towns come wholeheartedly into our scheme, the construction of highways would be proportionately slow in development. In Ontario and throughout Canada the construction of main arteries, our main channels of traffic, is as important to the country as the steam railway. The city and the township must join equally in the cost. The cities were slow in entering the field during the era of the horse-drawn traffic. With the growth of the automobile, the interest of the city has been stimulated, their people have been going out on the country roads and they see the state of those roads. They have been discovering that certain roads are good and that certain roads are of the other description, and they have been asking why. And we have been seeking to tell them why,—that certain roads carry the concentrated traffic upon which all join, and for which all must in equity expect to pay.

The automobile has increased the carrying capacity of the main highway how many fold? Two, three, ten fold, it is impossible perhaps to estimate, but we do know that the automobile can go five or ten times as far in a day as could the old horse-drawn vehicle, and it can carry four or five and perhaps ten times the load that the horse-drawn vehicle was able to carry. If roads were important to the civilization of the past, and to the people of the past, with horse-drawn vehicles, how much more important are they to the people of to-day with the carrying capacity that has come to them through the introduction of the automobile?

Yet Roads Will Not Be Financial Burden

If the cities of the past have been expected to pay their share, surely the cities of to-day must join in and meet this heavy outlay. Heavy in a sense, yes, but in carrying on this present war we have discovered that what seems a heavy financial undertaking is purely an attitude of mind. If we want good roads, we can pay for them. The financial cost that we have undertaken through this war would have previously seemed impossible to the most efficient of our financiers. To-day we see how it was accomplished. To-day the road problem payment seems heavy. When it is paid for, we will discover that we only had to do a day's work at a time and a year's work was finally accomplished, and we paid for it through our daily earnings at the end of the year, and it was not such a heavy burden after all.

I don't consider that the cost of the highways is going to stagger us at all. It will be immense, but our resources are adequate and the construction of those good roads will pay for themselves in the greater development of our country. All we need is faith and courage to go ahead, knowing that that will be the result. Past history has shown that it is. I believe that Ontario to-day has the foundation of one of the most equitable financial schemes of any country in the world, and I have studied them all. I don't think there is anything to surpass it. If there are any angles to be cut off, we can cut them off as they appear. If there is any filing or sandpapering to do, we can look after that, but we have the foundation of it, and all we need to do is to go ahead and use what we have and perfect it as we see that it ought to be perfected. We have a perfect foundation to work on. That is all we need to concern ourselves with to-day. If there are any inequalities, they will be taken care of as the work develops.

Equitable Distribution of Expense

We have an organization for taking care of the heavily travelled arteries and distributing the cost, and so on to the ordinary township road. I admit that in certain parts of Ontario, some special arrangement would seem desirable in connection with the ordinary township road, but that seems to me to be a matter for the future rather than for the immediate present when we have our main arteries to attend to and our systems of county roads, which will give the townships and the counties and the cities and the province perhaps all we should undertake at this stage of the work.

What we have is not at all final in the way of organization. It is simply the stage from which we must start to use what we have, and I believe that under it the cost will be equitably distributed without any heavy undertaking on the part of any individual or municipality.

HOT-MIX BITUMINOUS CONSTRUCTION, USING ASPHALTIC BINDER*

By E. Drinkwater
Municipal Engineer, St. Lambert, P.Q.

I PROPOSE to deal with this subject in a general way that will give the salient features and entirely leave the technical matters to the authorities of standard specifications now so easily procurable, and which can be obtained from any reliable manufacturer of paving materials.

First I propose to give a synopsis of the various methods employed by the writer during a period of from twenty to thirty years. I have been more or less the whole of my life actively connected with pavement construction, and previous to 1910 had always had to make use of that which was locally procurable and economically purchased, and had always adopted the mixed method for bituminous construction; that is to say, the fine or coarse stone aggregate was always coated with the bituminous binder before being placed in its pavement position.

Jarvis Street, Toronto, hot-mix asphalt, surfaced 1901, photo 1917. Repairs negligible

In the early days of my work I may say that we used gas tar procured directly from the gas works, at a very nominal cost. We coated the stone in dry, warm weather, without any heating. The tar was heated in what we called tar boilers, some of which were of a very large size and portable. In cold or damp weather we dried out and warmed the stone on plate floors heated by steam or hot air flues, such as we also used in brick-making. After coating, the stone was stored in the various sizes, separate and under cover until required for use on the work, and when laid was designated as tar macadam. It was laid in courses of 3-inch, 2-inch, and 1-inch stone to a total depth of 6 inches on either old macadam or a well-laid Telford base, and after many years of use these pavements would compare favorably with other more costly types of construction. These results were due, to a large extent, to the excellent quality of coal-gas tar which was available.

In 1909 I was called upon to construct pavement by the mixing method to a specification which called for the coating of stone first with hot tar and then with a second coat of hot asphaltic cement, and laid into position before the binder cooled. The mixing was done by hand on the site. When the weather was continuously fine and hot, this method gave a very satisfactory pavement, and after nine years' wear may be found in good condition to-day. But when the weather was unfavorable it was impossible to carry on the work satisfactorily, and any work done under unfavorable conditions as to weather, never proved good, and entailed considerable maintenance expenditure annually, due to the high cost of the sheet asphalt and other such manufactured pavement. We decided to adopt the penetration method. This was in 1911, and I laid a considerable mileage on old macadam and on new, well-laid and well-drained Telford base. For a time these pavements were seemingly satisfactory and economical to construct. It was not very long, however, before it was demonstrated that in accordance with the dry weather during construction, so was the quality of the pavement, and those sections that did not have the most favorable conditions began to disintegrate in fall, and the surface in the hot weather became out of shape.

It became manifest that the method could not give continuous good service and that the hot-mix method was the proper way in which the right gauging and mixing of materials could be obtained, and by the use of improvised plant I proved to my employers that better results could be obtained by its adoption, as it eliminated the bleeding in hot weather and was less slippery in cold weather on grades.

Since 1911 I have laid no pavement other than the hot-mix type, and according to the requirements used for city pavement,—sheet asphalt, where grade was flat, on concrete base, varying from 5 to 10 inches thick, according to the amount and class of traffic. On the same grade I have used asphaltic concrete (Topeka mix) on concrete base, which requires 4 per cent. to 5 per cent. less asphaltic cement than sheet asphalt, and is therefore lower in initial cost.

Quebec-St. Augustine Highway, hot-mix asphalt, now under construction. Laid on old macadam

On grades upward of 5 per cent. it is necessary that larger stone should be employed in the aggregate. This can only be done with the consent and under the Warren Brothers' patent covering Bithulitic and Warrenite pavements.

These pavements all entail a costly and immobile plant and considerable area to carry out the work of preparation of paving materials, and I propose to deal with the con-

*Address delivered May 10th, 1918, at Canadian Good Roads Congress.

struction method that may be used to build a fairly well-proportioned and thoroughly mixed pavement that will carry any class of traffic, and be constructed as continuously as any other type, and regardless of water supply, by machinery of low cost, and mobile, *viz.*, the ordinary concrete mixer with the heating attachment, traction wheel and distribution arm, that can be obtained from the many manufacturers of contractors' plant. After the base has been prepared in the maner decided upon and ready to receive the wearing surface, the machine can be placed on the travelled way or pavement area, and the material distributed along the line of work. It is preferable, however, if there is space available on the side of roadway, to place the machine there and protect the base; the construction to be carried out as follows:—

Mixing

Stone aggregate to be of a size that will pass a 2½-inch ring and retained by a 1½-inch ring, to be placed in the mixing drum and the hot blast applied. When the stone is heated to a temperature of approximately 250 degrees Fahrenheit, the asphaltic binder, previously heated in a portable heater to a temperature of not less than 200 and not more than 275 degrees Fahrenheit, is then added to the already heated stone, the quantity to be within the limits of 12 per cent. to 13 per cent. by weight of the total quantity of the stone in the mix.

Laying

When the stone is thoroughly coated, the batch should be emptied as soon as possible, and carried by the distribution arm, or any other means convenient to use, to the dumping platform if macadam base be used; if concrete base, on the base within spading distance of the laying

College Street, Toronto, hot-mix asphalt, laid 1903, photo 1917. Heavy traffic, repairs negligible

point, the mixture to be laid either by spade or fork, level and even to a depth of 3 inches loose, and well packed into position.

Rolling

When slightly cooled off, the rolling is done by a 12-ton macadam roller, care to be taken that the line and camber are maintained. Any hollow spots must be immediately levelled up during the rolling, and the roller kept moving until the pavement is thoroughly compacted. When this is done, and before the pavement is cooled, the mix in the machine should be changed.

Surface Coat

This consists of a mixture of three parts of stone, one part of rough sand, heated as the stone, and mixed with 12 per cent. to 13 per cent. asphalt cement, heated to the temperature of not less than 225 or over 275 degrees Fahrenheit. The stone and sand are thoroughly coated. When the mixing is completed, a surface treatment is given to the already laid and still warm pavement to a depth evenly laid of approximately ½ to ¾ inches in thickness, and as soon as laid the roller started again to drive this coat into the voids that may exist between the previously laid stone and here care should be taken to watch that any parts of the surface needing extra material

Spadina Ave., Toronto, hot-mix asphalt, after 16 years' heavy traffic. Repairs on asphalt less than one-fifth cent per square yard per annum

should receive it during the first rolling, when it will manifest itself. When sufficiently rolled, the whole pavement should be then just covered with a coat of warm stone chips of ¼ inch down, and as soon as cooled off, the pavement may be used for traffic.

Asphaltic Cement

Any well-known brand that will fulfil the standard specification requirements of a penetration of from 60 to 90 at 77 degrees Fahrenheit, will be a satisfactory material to use for this class of work.

Mixer

A standard mixer of ¾ yard capacity will turn out 800 to 1,000 yards per day, or 200 yards of 16-foot roadway per day, and can be operated either by steam or gasoline power, and the heater be provided with crude oil burners. The traction attachment makes it possible to eliminate considerable haulage delay and the machine can always be kept alongside the work being laid.

In conclusion I beg to say that I find the asphaltic cement binder a satisfactory material to use, due to the fact that its natural ductility allows ample time for compacting before setting up. It is less subject to variation of temperature than any other material, and climatic changes have no effect. In spring and fall it does not get excessively hard and slippery, and in summer the heat does not have any appreciable effect, and at all times it will carry any load that the foundation will carry. It will give good service, easy to repair and low in maintenance cost.

THE EFFICIENCY OF THE HIGHWAY IN THE PRESENT TRANSPORTATION DIFFICULTIES*

By Col. William D. Sohier
Chairman, Massachusetts Highway Commission

EFFICIENCY is the ability to accomplish work with a minimum of time or energy. The efficiency of good highways is well shown by a report which I received on April 19th, 1918, on road tests with motor trucks, by R. E. Chamberlain, of the Packard Motor Company. Mr. Chamberlain made some elaborate tests to determine the relative value of different road surfaces under operation of motor trucks. Results of these tests show the resistance to tractive effort offered by unsurfaced concrete to be 30 pounds per ton, surfaced concrete 50 pounds, gravel 82 pounds and dirt 99 pounds.

A three-ton truck, with capacity load, which maintains a speed of 12 miles an hour over unsurfaced concrete, will make 7.2 miles an hour over surfaced concrete, 4.8 miles an hour over gravel and 3.6 miles an hour on dirt roads. relative cost per ton-mile is \$.167 on surfaced concrete, \$.194 on gravel, and \$.207 on dirt roads. Mr. Chamberlain in his report states that "a computation would show that if all roads travelled were gravel instead of dirt, annual savings in operating America's 400,000 motor trucks would amount to \$70,200,000; if concrete instead of gravel, \$167,400,000; and if concrete instead of dirt, \$237,600,000."

Roads a Big Factor in the War

The fact that the tractive resistance of an earth road is 306 lbs. as compared with 83 lbs. for concrete, is of the utmost importance at the present time, as the results of the war will depend fully as much upon roads and highways as upon any other one factor, because it is manifest that if you cannot feed your men, move your guns, supply them with artillery and ammunition, you cannot maintain an army in an existing location. While the railroads and steamships are vitally necessary to bring the supplies and men, ammunition to the artillery, and everything needed for modern war, to the country, and from the large storehouses to the railheads, the soldiers in the trenches, and more particularly the soldiers back of the trenches, have to be almost entirely supplied over the roads.

The whole battle of Verdun was really fought, so far as the French were concerned, with soldiers, ammunition, guns, and supplies that were transported over the roads, because the one railroad which originally supplied that region was cut by the Germans, and the other one was dominated by their artillery. The consequence was that the army was supplied with ammunition, guns and men that came over the roads.

All Important Roads are Military

From one point of view, all roads which are of any importance are military; to wit, any roads which have to be used for the transportation of any of the products which are necessary for the conduct of the war or the feeding of the people with the articles that are necessary to sustain life. It is a question of relative importance, but under existing conditions we should certainly confine our efforts to those roads which are of the most importance from this point of view.

Practically all of the roads in France were military roads. The French road system was admirably adapted to be used for military purposes. This can be illustrated by a few figures.

France, with a population of ten times that of Massachusetts, and an area of about twenty-five times the area of Massachusetts, had, when the war started, over 371,000 miles of macadam road. These roads had been built for many years; they were all graded, with foundations where necessary, and all had adequate drainage. Virtually all had a hardened surface of waterbound macadam, though a certain percentage had been built with a bituminous surface.

There were about 32,000 miles of national or departmental highways, or about 10 per cent. of the whole. These main arteries connected all the more important cities and villages with a network of main highways through the whole of France.

The width of the "Route Nationale," including ditches, was 60 ft.; the macadam surface was usually 24 ft. wide, with about 15 ft. of graded road on each side and then a ditch. The "Route Departmentale" was about 42 ft. in width, with a macadam surface usually about 18 ft. wide.

French Roads Helped to Save Paris

There were also over 107,000 miles of road of secondary importance, what might be called county roads, connecting all the little towns, villages and hamlets. There were 47,500 miles of road that were perhaps of interest to two or more towns. These roads were graded about 30 ft. in width, including ditches. Then there were about 184,000 miles of what might be called ordinary country roads. The roads of the least importance had a macadam surface about 9 ft. in width, but were graded 27 ft. in width.

So far as I can learn, it was this road system which enabled the armies of France to stem the German armies' rush on Paris, and to throw them back to where the trenches were first dug. France has been so well supplied with roads in most of the sections on the battle line that it has been unnecessary to build very many new ones. The big problem has been to keep up and maintain what they had, with the tremendous traffic that had to go continuously over them.

By way of comparison with the French mileage, I may say that Massachusetts has about 23,000 miles of roads, of which about 6,000 miles are village, town or city streets.

I tried an interesting experiment recently with a French map. I could not put a pin on any point on the map which was further than one mile from a macadamized road.

The French roads are not accidental. They have not happened. They are well designed and built to better plans, better grades and better alignment than is the practice anywhere on this continent,—but even those roads could not stand the pounding by army traffic. The French road system was started in 1826 by a decree of Napoleon. The location, width, alignment and grade of the whole system as originally planned has been very largely adhered to, so that their policy has been continuous.

Planned in Napoleon's Time

Some time ago I asked a high French road official how many miles there were of macadamized roads in France. He replied that there were 400,000 miles. Later I wrote for further information and secured the names and mileages of the various roads. Upon adding these, I discovered a total of only 371,000 miles, or nearly 30,000 less than the figure originally given. I wrote again enquiring where the error had been, and received a most gracious apology and explanation that only 371,000 had really been built,

*Abstract of address delivered May 8th, 1918, at Canadian Good Roads Congress.

but that 400,000 had been planned, and that as an engineer he considered the system as planned, as a whole, rather than the part that had been completed. The remainder did not matter; it had been planned, ergo it would be built, someday, even though it had been planned since 1826 and was not yet built. But there is not the faintest doubt that those other 29,000 miles will be built and exactly as planned. We can learn much from far-sighted and clear planning for the future such as practised by the French road engineers.

Knowing the tremendous traffic that any road directly used for army purposes will be required to carry, we must build our bridges and roads accordingly.

Trucks Increasing, Better Foundations Needed

The main thing that our roads must be made to stand is the continuous pound and wear of the 3 to 5-ton trucks and of the heavy wagons on iron tires with 4 to 6-in. wheels, the weight of which will not exceed, probably, 3 tons. Each of us in our own locality must see that we use materials, if possible, that are capable of withstanding this traffic.

I think we should all pay a great deal more attention to the foundations of our roads than we have done in the past, when the traffic was lighter. In my own State there is a tremendous commercial traffic in motor trucks. They are constantly on the increase. Most of our main roads have to carry 100 to 150 a day, and some of them have a much larger number. This is going to require stronger roads, thicker macadam, and a foundation in a great many places where the old macadam or gravel road would have held under the traffic of a few years ago without such foundations.

To do this, we must have federal government cooperation and support. I have some roads in Massachusetts that are perfectly alright for the traffic which they would normally experience, but if the government trucks keep pounding over them for another three or four months, I won't have any roads left at all in certain localities unless the government provides the money to maintain them in the unusual manner necessary.

We are getting 1,000 vehicles a day and from one hundred to two hundred trucks on old macadam that is fast being ruined. I know of one road in Maryland and Virginia over which the government has been running 150 trucks a day and it simply went to pieces. Our roads were built too poorly, most of them, for this sort of traffic, but the government is now beginning to co-operate properly and no doubt the Canadian government will do the same sooner or later.

Auto Trucks Will Carry Most Freight

If money be very limited, spend it first of all on drainage. Build the ditches, provide your drains, form your surface. Then put in a good foundation if you can take another step.

The motor traffic of France and England is nothing compared to the motor traffic in Ontario or in the United States. All the autos in France do not number as many as the taxicabs in New York City alone.

England does not expect to be invaded, and yet as a war measure the British parliament has voted something like $5,000,000 a year for the up-keep of roads in Great Britain.

Our government is working at cross purposes in dealing with the question of supplementing our railroads with truck traffic.

In the past we failed to look far enough ahead in building roads. The time is coming when most of our freight carrying will be done by auto trucks. We must build our roads heavy enough to carry trucks.

The United States government is using trucks to deliver army contract goods, for in such cases it is time, not money, that counts.

The cost of the road must not be looked upon too seriously as it will generally be more than offset by the savings it will effect. I could cite innumerable instances where improvements in highways have more than paid for themselves. In one case three-ton loads are being hauled where three-quarter-ton loads were previously the maximum. In another instance milk is being trucked over a new highway to an adjacent city for a half cent a gallon, where the railroad formerly charged one cent. In addition, the farmers are also saved the cost of hauling to the railroad station and the cost (one cent) of carting from the station in the city to the distributor's plant. The farmers along that highway are saving $71,000 a year as a result. The road is 13 miles long and cost about $260,000. The saving far more than pays the interest, sinking fund and maintenance. One farmer saves $150 in the hauling to market of his cabbages alone.

Roads Pay For Themselves

Suburban roads increase land values to such an extent that the extra taxes more than remunerate the municipality for the expense. One road near Boston is 1½ miles long. It goes partly through what was a market garden and partly along a hardly passable hillside. Within eighteen months of the start of construction on that road, twenty-six new houses have been built averaging about $2,500 each. Four sideroads join the new road. These have been partly developed and four houses are going up along them. The farm land was worth $500 an acre and the hillside land $200 an acre. The building lots are selling at $750 each, 8 lots to the acre. The road cost about $45,000 and the municipality is already collecting over $1,000 annually more taxes than previously owing to increased valuation. It will soon collect a sufficient increase to meet the interest, sinking fund and maintenance of the road, without any doubt. The bonds were issued at 4¼ per cent, I believe, and the required annual sinking fund is about 1¾ per cent., so that they are already collecting a substantial portion of the interest and sinking fund charges. The road is bituminous macadam, penetration method, with a concrete base where necessary. It is 18 ft. wide, with a 3-inch gravel shoulder along each side.

People have said to me, "Why don't you stop the road building during the war, and let the labor go onto the farms?" Well, we employed more men and reduced their working hours, and when they finished their eight-hour day, they were still willing to help the farmer.

W. A. McLean, deputy minister of highways for Ontario, in discussing the above address, said: "We surely will have to reconstruct roads between towns and cities strongly and heavily enough for the motor truck traffic. It means that we must put in foundations strong enough to take care of heavy concentrated wheel loads.

"I believe that all our highways are military highways. If the highway which saves the farmers' time is not a military highway, I don't know what is."

The Toronto Harbor Commission has moved from its leased offices, on Bay St., to its own new building on the waterfront at the foot of Bay St.

CANADIAN GOOD ROADS CONGRESS

(Continued from page 430)

At 1 p.m. the annual meeting of the Canadian Automobile Association was held, with L. B. Howland in the chair. Mr. Howland stated that since the last annual meeting, the number of automobiles in use in Canada had increased by 100 per cent. With over 200,000 cars in operation, Canada to-day ranks third among all the countries in the world in regard to the number of motor vehicles owned and operated.

Col. William D. Sohier, chairman of the Massachusetts Highway Commission, said that he had found the co-operation of the automobile associations the greatest single asset in making progress in the road movement.

May Establish Auto Freight Depots

Arthur H. Blanchard, consulting highway engineer of New York City, urged that in making traffic regulations in Canada, there should be kept in mind the importance of the problem of motor freight traffic on the highways. "That," said Mr. Blanchard, "is an even more difficult question than the regulations for the passenger traffic. We have in New York State a committee which is composed of some of the most prominent authorities on highway work, who are planning uniform regulations for all cities for motor freight traffic.

"We in New York are also deeply interested in what is called 'the return load guarantee,' whereby arrangements can be made that freight autos can be assured a return load from the point of delivery of the original load. This guarantee reduces the cost of freight traffic. For this purpose we would have to have auto freight depots where loads can be called for and delivered. At present, however, we have not gone beyond the stage of investigation and plans."

W. A. McLean stated that there are about 80,000 automobiles in Ontario to-day, of which number approximately 5,000 are trucks and lorries. The business men of Ontario are using 14,000 cars and about 20,000 are used by the skilled tradesmen, carpenters, plumbers, etc. Therefore fully 39,000 of the 80,000 motors in Ontario to-day are used at least in part for business, and no doubt a great many of the other 41,000 also are frequently used for business purposes.

Predicts Main Trunk Lines for Freight

"Among the cities in Ontario which have been neglected so far as good roads are concerned," said Mr. McLean, "is Ottawa." He promised that Ottawa will be one of the first cities to receive consideration when the provincial programme for an extensive good roads system is carried out.

James H. MacDonald predicted that in time we will require main trunk lines reserved solely for carrying freight. "Therefore, in constructing roads like the Toronto-Hamilton Highway," said Mr. MacDonald, "you are building better than you know."

Col. William D. Sohier, chairman of the Massachusetts Highway Commission, was the first speaker of the Wednesday afternoon session. An abstract of his address on "The Efficiency of the Highways in the Present Transportation Difficulties," appears on page 444 of this issue.

Col. Sohier was followed by Lieut.-Col. W. G. MacKendrick, D.S.O., president of the Warren Bituminous Paving Co. of Ontario, who delivered an address on "How the Good Roads of France are Helping to Win the War." Col. MacKendrick is the director of roads of the Fifth British Army. He is in Canada for a short time on special furlough. An abstract of Col. MacKendrick's address appears as the leading article of this issue.

"English and American Practice in the Construction of Tar Surfaces and Pavements" was the subject of an informative address by Prof. Arthur H. Blanchard, consulting engineer of New York City. Mr. Blanchard's lecture was illustrated by a large number of lantern slides. He said that the people of the United States now realize that the solution of their transportation problems depends upon the highways. He expressed regret that chaos reigns in the United States in respect to highway transportation, construction and maintenance, but stated that the efforts of the various semi-public organizations are now bearing fruit, and Congress will no doubt place the control of this part of the country's war work in charge of one department.

F. Howard Annes, of Whitby, Ont., spoke on "Highway Widths." Mr. Annes' speech is published on page 437 of this issue.

"The Border Is Still There"

The annual dinner of the association was held Wednesday evening at the Royal Connaught Hotel. The vice-president, S. L. Squire, who was later elected president for the ensuing year, acted as toastmaster.

W. A. McLean proposed the toast to "Our Guests." James H. MacDonald replied in a most eloquent, patriotic and inspiring address. Mr. MacDonald incidentally complimented the city of Hamilton upon its drainage system, which he said is most modern. Mr. MacDonald is an accomplished orator and he was called upon to speak upon every possible occasion, as his talks were all much enjoyed.

B. Michaud, deputy minister of Highways for Quebec, explained how the road policy of his province differs from that of Ontario. "We built the trunk roads and supplied the money for the local roads," said Mr. Michaud. "Perhaps a beter way is the way which the people of Ontario have chosen. Here you have studied the conditions, prepared the assessments, etc. That is, you have first consulted your resources. We could not do that. We could not classify the roads upon a scientific basis. We had no time to do so, as we wanted the roads at once. We built five trunk roads amounting to 300 miles, and we have a sixth one under construction which will be completed this fall. During the past few years we have spent about $18,000,000 on roads. In making this expenditure, our thought was not only of Quebec, but of all Canada. We thought of the Canadian transcontinental highway. Even our municipalities built roads which are ready to form a part of such a transcontinental highway. We have built roads to the boundary of Ontario. We are at your door, at the border of your province, but so far as roads are concerned, the border is still there."

"Old Dammit" Back Again

Lieut.-Col. W. G. MacKendrick explained the engineering vocabulary which is necessary in handling 12,000 men in constructing military roads. He said that he started out early every morning inspecting his road work, making upwards of forty calls a morning, and that he frequently had occasion to use an expression that he had learned some years ago when on railway construction work. Last summer he was ordered for a time to the Ypres salient. While walking along a railway track the first morning after his return to his former section, he passed two privates of his old labor battalion. "Hi say, 'Arry," called the one to the other, "'eres old Dammit back again."

George Henry, M.P.P., representing the Ontario Good Roads Association, said that when we get back to normal conditions we will need every agency for the development of the country, and that no agency would be so important to mankind generally as the public highway. Mr. Henry explained that the reason for the absence of Mr. Wheelock, the president of the Good Roads Association, was that the latter had but recently lost his eldest son, a member of the Royal Flying Corps.

Difficult to Maintain Roads in U.S.A.

Col. Sohier explained the difficulties of maintaining roads in the United States under war traffic. He said that he had made the suggestion that all the highway commissioners get together and decide what roads are the important ones, what roads should be built and what roads maintained. At present there are ten different departments in Washington which have to be considered in connection with any road work. He needs a large quantity of road oil very urgently, and so far has been able to get only fifteen carloads. His roads will be ruined if he does not get the oil, he said. Sixty-eight men from his department have enlisted or have been drafted for the army and navy.

L. B. Howland, who was re-elected president of the Canadian Automobile Association, and R. T. Kelley, president of the Board of Trade of Hamilton, also spoke very briefly.

Moving pictures of the Columbia Highway were shown Thursday morning, followed by an illustrated lecture on drainage by Jas. H. MacDonald. Ninety per cent. of all the trouble with roads to-day is due to the lack of intelligent drainage, said Mr. MacDonald. Countless evils result from the lack of proper knowledge of this subject. He showed a number of views of the roadways in his state under spring-time flood conditions. The photographs proved conclusively that road building in Connecticut requires a knowledge of drainage. The speaker dealt briefly with the various salient features of the subject. Certain principles of road building had been standardized and were the best to follow. With the aid of the slides, he illustrated the primary steps in road-building. The hog-back road was shown to be dangerous and expensive. The old-fashioned, rubble centre drain had been found by the speaker to be unequalled for all practical purposes. Blind drains, in his judgment, were very inefficient. Proper water breaks, the prevention of warts, and the most effective methods of widening narrow and uneven roads, were among the matters he discussed. The practical value of the rim-edge, cobble gutter was shown.

The three great ideas in drainage, said the speaker, are to get the water off the roads, to get it out of the roads, and to keep it away from the roads. Lack of proper drainage of the subgrade caused much damage, being responsible for cracks and other evils. Mr. MacDonald described in detail the building of a Telford roadbed, which, he claimed, is in his opinion the best type of construction, and one which would last for centuries.

The discussion of Mr. MacDonald's paper was adjourned until the afternoon session in order to permit the executive of the association to motor over the Toronto-Hamilton highway to Burlington, and to be the guests of the Hamilton Board of Trade at luncheon.

B. Michaud opened the discussion on Mr. MacDonald's paper at the afternoon session. He asked whether there is any road so good as the Telford, but cheaper. Mr. MacDonald advised making use of the material nearest the district in which the road is to be constructed.

Canada Should Benefit by U.S. Mistakes

Mr. Fraser, of Quebec, asked which is the better, the side or the base drains. Mr. MacDonald replied that the base had proven to be the better.

Mr. MacDonald stated that of all the roads and bridges in the United States, there are not 10 per cent.

Executive of the Canadian Good Roads Association

GEO. A. McNAMEE
Secretary-Treasurer

S. L. SQUIRE
President

JULES DUCHASTEL
Honorary Past President

that can carry 15-ton motor trucks. Canada should benefit by the mistakes of the United States.

Extended discussion arose in regard to the relative merits of cement and clay pipes. It was decided that both have their merits.

B. Michaud extended an invitation from the city of Quebec, and urged that the next convention be held in that city. W. P. Near, city engineer of St. Catharines, Ont., presented a letter from the mayor of that city, asking for the 1919 congress. The executive decided to go to Quebec next year, but may meet in St. Catharines in 1920.

L. B. Howland spoke on what motorists can do to help the good roads movement and relieve the transportation congestion. Motor trucks are in their infancy, said Mr. Howland. In the United States, 1,300,000,000 tons of material were hauled by motor trucks during 1917, at an average of 18c. per ton, a saving of 10c. over horse-drawn vehicles. The motor truck will abolish the short railway.

Discussion on Concrete Roads

W. H. Connell, consulting engineer, of Philadelphia, who was on the programme for a paper on the result of tests of various types of pavements, was unable to be present.

A. Lalonde, C.E., assistant engineer of Outremont, P.Q., spoke on concrete roads. His paper is published in full on page 433 of this issue.

Mr. Cadwell, of Windsor, Ont., said that he did not think it necessary to keep the traffic off new concrete roads for so long a time as is now the practice. "I have seen a three-ton truck taken over a concrete road twenty-four hours after its construction," said Mr. Cadwell, "and not a mark of the wheels was left on the road." The general opinion was that the engineer who permitted the truck to go over the road, had taken a great risk, and that the road might have been injured, even though unmarked.

The question box was cleared and a brief general discussion took place on the questions which had been submitted. The various types of machinery for snow cleaning were discussed as the result of one question. Mr. Duchastel said that his municipality, Outremont, P.Q., cleaned its streets last winter by the use of a new machine with a saving of fully one-third of the cost by cleaning with wagons and sleighs.

Following the afternoon session, the delegates and guests were taken on a motor trip around the city by members of the Hamilton Automobile Club.

The works department of the city of Hamilton tendered a dinner to the executive of the association and their guests early Thursday evening, and at 9 p.m. the annual meeting of the association was held.

Directorate Increased to Twenty

A. A. Dion, of Ottawa, was elected as chairman of the meeting. An advisory board of all past-presidents was formed, and the following officers elected for the year 1918-19:—

Hon. past-president, Capt. J. A. Duchastel de Montrouge, Outremont, P.Q.: president, S. L. Squire, Toronto; first vice-president, A. F. Macallum, Ottawa; second vice-president, P. E. Mercier, Montreal; secretary-treasurer, Geo. A. McNamee, Montreal. Directors:—The officers and A. L. Caron, Montreal; Dr. E. M. Desaulniers, St. Lambert; R. S. Henderson, Winnipeg; L. W. Levesque, Montreal; J. A. Sanderson, Oxford Station; L. B. Howland, Toronto; C. R. Wheelock, Orangeville; W. G. Yorston, Halifax; Wm. Findlay, Ottawa; R. T. Kelley, Hamilton.

Upon motion of Capt. Duchastel, the directorate was increased to twenty, the additions to be chosen by the present board from the deputy ministers of the provinces.

Several amendments to the constitution were passed in order to make the constitution conform with the federal charter which had been obtained during the year. Advisory boards were formed for the province of Quebec and the province of Ontario, and separate meetings of the Quebec and Ontario executives will be held. A number of votes of thanks were unanimously adopted.

The last session of the congress was held on Friday morning, May 10th.

E. Drinkwater, municipal and highway engineer of St. Lambert, P.Q., delivered an address on the hot-mix method of bituminous construction, using asphaltic binder. His paper will be found in full on page 442 of this issue.

C. A. Mullen, director of the paving department of the Milton Hersey Co., Ltd., Montreal, was on the programme for a paper on asphalt pavements. Mr. Mullen was unable to attend, but he forwarded his paper, and this paper was also read by Mr. Drinkwater. It is published in part on page 449 of this issue.

E. R. Gray, city engineer of Hamilton, read a paper on the abatement of the dust nuisance. This paper will be found on page 431 of this issue. The chairman, Capt. Duchastel, in discussing Mr. Gray's paper, said that the cost of applying tar last year to the streets in Outremont, was about 2½c. per square yard, which was somewhat higher than the cost of oiling in Hamilton. A general discussion on oiling followed Mr. Gray's paper. Capt. Duchastel considered oiling to be the most economical and sanitary way of dealing with the dust problem.

Paul S. Sargent, engineer of the state highway commission of Maine, who was on the programme for a paper on gravel and macadam roads, did not arrive, so after the discussion of Mr. Gray's paper had been finished, the chairman declared the congress adjourned.

COST OF OILING IN TORONTO

"It is costing this year 35 per cent. more for oil and 11 per cent. more for labor than was paid last year," says Street Commissioner Wilson, of Toronto, in a report to the city council, "so that to treat the same mileage of streets as last year, on the basis of 3.5 applications, would cost approximately $31,694.24, or $6,694.24 more than has been provided in the estimates. It will be obvious, therefore, that we cannot, without overdrawing or appropriation, treat the same mileage as was treated in 1917."

The commissioner points out that "there are 176.89 miles of macadam, Rocmac, and unimproved roadways in Toronto. The policy is to oil only such of these streets as it is absolutely necessary to oil, having regard to traffic conditions and the density of the population.

"To oil one mile of roadway, 24 feet wide, or 14,080 square yards, applying one-tenth gallon per yard, at 12.5c. per gallon, costs the department $176, plus $5.11 for labor, or a total of $181.11 for one application."

Geo. F. Porter, designing engineer of the St. Lawrence Bridge Co., will read a paper on the Quebec Bridge next Monday evening at a meeting of the Manitoba Branch of the Canadian Society of Civil Engineers.

ASPHALT PAVEMENTS*

By Charles A. Mullen
Director of Paving Dept., Milton Hersey Co., Ltd., Montreal

THE broad subject assigned to me is far too comprehensive to fall within the scope of a single paper. We will therefore brief those parts which are of historical or general interest, and pass on as quickly as possible to the consideration of the phases of the subject that are of present-day interest to the modern road-builders of North America.

The sheet asphalt pavement is not a modern invention. This material was used for street covering purposes by the ancients, and sections of it have been dug up with the other evidences of past civilizations. Having in mind the centuries that have elapsed since its first employment as a street pavement, the surprising thing is that so little progress has been made in its development, and practically none until recent years.

American Asphalt Introduced About 1870

The European asphalt pavement is the rock asphalt, it being prepared from native bitumen-impregnated rocks. The natural substance is ground to a powder, heated, spread and then compacted by tamping or very slow rolling. To secure the best results, two or more rock powders from different sources and having different characteristics are combined to produce a better grading of mineral aggregate and a more satisfactory bitumen content. Many very good asphalt pavements have been laid with this material in Europe, and some on this side of the Atlantic.

The American asphalt pavement was first produced by E. J. De Smedt about 1870, and may be considered as an attempt on his part to imitate, at a less cost in this country, the rock asphalt pavements of Europe. The Europeans still term rock asphalt pavements as natural and the American product as an artificial asphalt pavement. As has happened in many other cases, the substitute leaves nothing to be desired of the original.

The first asphalt pavement of the American or artificial type to attract wide attention was that laid on Pennsylvania Avenue in the city of Washington, D.C., about 1876. Congress provided that this national thoroughfare should be paved with sheet asphalt from the Capitol to the White House, that section east of Sixth Street to be rock asphalt and the section west thereof to be artificial asphalt. Previous sections of pavements laid in other cities had been of but small yardage and of an experimental nature.

Mineral Aggregate Most Important

The modern asphalt pavement consists of a mineral aggregate of specially graded sand and impalpable dust, thoroughly mixed, and bound together with asphalt cement. Roughly speaking, the mineral aggregate is 90 per cent. by weight or 75 per cent. by volume, the specific gravity of the bitumen in the asphalt paving cement being but slightly more than that of water. The grit mixtures and the "stone-filled" sheet asphalts are the same with a small proportion of fine stone chips added, not usually over 30 per cent.

The asphalt paving cement is, of course, a vital matter, since we could not have an asphalt pavement without it. More pavements fail to-day, however, because of the lack of an understanding of the necessary requirements for the mineral aggregate, or carelessness or ignorance in the making of the paving mixture. Our public officials frequently go to great lengths to make sure that the materials furnished are what they should be, and then permit those materials to be spoiled at the asphalt mixing plant.

Many good asphalt cements are on the market to-day. They are manufactured from crudes found in Mexico, California, Trinidad, Bermudez in Venezuela, and elsewhere. All are of so nearly equal value that only the uninformed or specially interested will to-day pay a great difference per square yard for asphalt pavement in which one or the other has been properly used. The per square yard competitive basis, under carefully drawn specifications crude materials they are made nor by whom. Some·public in wholesome communities.

Penetrations of Asphalt Cements

Asphalt cements need testing no matter from what crude materials they are made nor by whom. Some public officials do not seem to think so; but could they know how well they are spotted by the supply houses, and how carefully this frame of mind is cultivated for them, they would very soon change these views. Doubtful material, or material that has been condemned by some careful official who does have his deliveries tested, is always shipped to the other man.

The consistency or penetration of the asphalt paving cement is the first point to which we look. In a material that is pure, and with a mineral aggregate that is properly graded, it is customary to use the following classes of material for the different conditions of traffic in this climate:—

Heavy traffic	45 to 55 penetration
Medium traffic	55 to 65 penetration
Light traffic	65 to 75 penetration

Unless otherwise specified, all penetration tests are made with a No. 2 standard needle acting for five seconds under a load of one hundred grams at 77 deg. Fahr.

The ductility and other tests are of great importance in determining the quality of the asphalt cement, but they are more particularly the concern of the asphalt chemist, and must receive close attention at the laboratory. The field engineer should be in close touch with the chemist and know the general characteristics of the asphalt cement he is using, but we will pass these points for the present to discuss others that are of more immediate importance to the greater number of us.

Cut-Back Asphalts

Fluxed or cut-back asphalts are so little used to-day that they no longer present a serious problem,—at least, not in Canada. It is much easier to manufacture asphalt paving mixtures from cement that is delivered at the mixing plant at the desired consistency than when the cement must first be manufactured from crude or refined asphalt and flux oil. As a general proposition, the promiscuous cutting-back or fluxing of oil asphalts that have been refined to a hardness greater than that desired, should be discouraged. While it is not necessarily harmful, and might even be beneficial, it is always at least a subject for close question. The native asphalts are naturally so hard that they require fluxing with some other suitable material before they are usable in asphalt paving at all, so the foregoing remarks do not refer to these materials.

The inorganic dust or filler is a factor of prime importance. The material most commonly used is limestone dust pulverized in a grinding mill to such fineness that at least 75 per cent. will pass a standard 200-mesh testing

*Paper prepared for the Canadian Road Congress, May 7th to 10th, 1918, at Hamilton, Ont.

sieve. When the material is less fine, more must be used to secure a given result; and, as the inorganic dust is usually introduced cold at the mixer into the hot sand of the bulk of the mineral aggregate, the result of using too much of this cold material is obvious. Such mixtures, in that they approach the aggregate of rock asphalt pavements, are also harder to lay in the manner usually employed in the construction of the artificial or American pavement.

Stone dust and Portland cement are the most widely used filler materials, the former being the more common because the lower in cost, but the latter being preferred by some on the ground that it is thought to make a superior mixture. When Portland cement is employed, the difference in specific gravity between that material and the remainder of the mineral aggregate should be taken into consideration, as the mixtures are usually figured by weight instead of by volume, though the latter would seem a more logical method if it could be used with reasonable convenience.

Filler Materials

Other filler materials are pulverized clay, marl, shale, silica, etc. Many materials have been tried and found satisfactory, but a few have produced disastrous results. "Safety first" demands that a new material be thoroughly investigated before it is used extensively as an asphalt pavement filler. These investigations can only be conducted in a properly equipped laboratory, and by those with comparative experience to draw upon.

The 200-mesh sieve is not a sufficient test for an inorganic dust filler, except for routine work on a known material. The particles of dust that are of the most value are those that would pass a 500-mesh sieve, were one of such fineness of practical value for laboratory testing.

Two-hundred-mesh fine sand was offered to the city of Montreal as a filler material last season. A deposit of this material, practically all of which would pass the 200-mesh sieve, had been uncovered in a local sand pit, and it was offered to the municipal purchasing department at a fancy sand price as a substitute for the more expensive stone dust. It had to be rejected on the ground that, though it passed the specifications under which bids had been received, it was not a proper filler material at all, there being practically none of the finer material for the separation of which no laboratory sieve is practical, and which is the really important factor in a dust filler.

Photomicrographs of Sand

Photomicrographs saved the day in this instance. It was a rather difficult matter to advise a city purchasing department that the material which passed their specifications better and was about 50 per cent. cheaper than stone dust, should not be bought and used; but when we submitted comparative photomicrographs of the part of each material that had passed the 200-mesh sieve, and it was seen that the sand grains looked like rocks under the same magnification that still left the stone dust grains the appearance of fine powder, even the low bidder who was offering the fine sand was satisfied that his material would not serve the purpose.

The air separation dust test is by far the most satisfactory that we have yet found for making comparisons of materials. Water separation gave some good results, but the air method seems more practical. Neither is sufficiently simple to be used on routine work, so the 200-mesh sieve must still be relied upon for much of the checking of deliveries with samples submitted. As we do not know of any other air or water separators of the type we are using in Canada, they being especially constructed by us, it is hardly worth while at this time to use these tests in specifications.

The specially graded sand that forms about 75 per cent of the weight of a standard sheet asphalt pavement surface is a very simple matter if one fully understands and appreciates what is necessary. To fully comprehend the very great difference in an asphalt pavement mixture that the grading of the sand will make, one has but to follow daily on the street the work turned out by a mixing plant where the man in charge is careless of detail, or thinks that any old sand grading at all is good enough.

Sand Must Be Watched

We have seen a mixture produced by an asphalt paving plant at one o'clock that was all that could be desired, and at four o'clock of the same afternoon that plant was turning out, under the same formula of batch weights, a mixture that was not even third-rate. The reason was that no attention was being paid to the sand. At one o'clock, the supply was being drawn from a section of the pile that by chance happened to be of a very good grading, but by four o'clock the laborers had worked into a large pocket where the sand was very coarse.

The result of this carelessness was a poorly graded, sloppy mixture, that could not be expected to give good service under heavy traffic, and that cost as much as the better mixture even for light traffic. It will mark badly in warm weather, and probably shove, whether it has a binder course or not. The quantity of asphalt cement that is correct for a mixture having the standard grading of mineral aggregate is far too much for a mixture in which the sand is coarse. A plant crew that was not well enough organized and trained to watch the sand pile could not be expected to know when the proportion of asphalt cement should have been reduced to prevent a sloppy mixture.

Three grades of sand are needed in most cases to approximate sufficiently the standard or model sand grading. These may, for convenience, be termed fine, medium and coarse grade sands for asphalt paving purposes. It may assist the layman to an understanding of the matter if we say that the fine is of that size which is sometimes spoken of as blow sand, the medium a good plasterer's sand, and the coarse a sand of the type we all recognize as suitable for Portland cement concrete work.

The Various Grades of Sand

One sand is occasionally found that is in itself a sufficient approximation of the standard grading; but such cases are rare, and, even then, it is a good precaution to have on hand small stocks of fine and coarse sands for tempering purposes in case the main supply does not at all times prove sufficiently uniform. Sometimes a well-graded sand may be secured from a stratified bank by working a face to a certain depth that will take in layers the mixture of which in falling and handling will give a satisfactory approximation of the model. This we succeeded in doing with good effect last season at Woodstock, Ont.

Fine sand for asphalt paving is one in which there is a decided predominance above the percent. required in the model grading of those sized grains that will pass a standard 80-mesh and be held on a standard 200-mesh sieve. The requirement of the model sand grading is 34 per cent. of the total sand.

(Continued on page 452)

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Principal Contents of this Issue

BRITISH COLUMBIA "INSTITUTE"

ONE HUNDRED civil and mechanical engineers, draftsmen, surveyors and architects in British Columbia recently sought provincial incorporation under the name of the "Engineering and Technical Institute of British Columbia." Their bill was disallowed on a technicality when first introduced, and by payment of double fees the promoters secured permission to reintroduce it. But the legislature prorogued on April 23rd without having discussed the bill, as the private bills committee had reported against it; consequently the proposed legislation is dead for this year at least and probably for all time.

Now that the Canadian Society of Civil Engineers has broadened, and has changed its name to the Engineering Institute of Canada, it would have been unfortunate had the British Columbia legislature allowed the use of so similar a name as the "Engineering and Technical Institute of British Columbia."

The bill was sought upon wrong premises. The reason for the bill, as outlined therein, was as follows:—

"Whereas it was deemed expedient for the better protection of the public interests, and for the general advancement of mechanical science, and more particularly for promoting the acquisition of that species of knowledge which has special reference to the profession of engineers, architects and technical professions, and to encourage investigation in connection with said profession, and in order to enable persons requiring professional aid in any work to which such knowledge of engineering, architecture and technical knowledge is applicable or necessary, to distinguish between qualified and unqualified members of such professions. Therefore, His Majesty enacts as follows," etc.

"Persons requiring professional aid in any work" are now partly able "to distinguish between qualified and unqualified members of such professions" by ascertaining the engineering degrees held by the engineer under consideration, or by consulting the lists of members of the Engineering Institute of Canada, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers and other Canadian technical organizations or Canadian branches of American engineering societies.

It is true that some of these societies contain members who are not well qualified engineers, so that membership in any one of them is not a sure sign of ability, but surely it indicates a probability of ability, as at least nine-tenths of the membership of any such society, at a conservative estimate, are technically qualified for some kind of engineering work. There was no guarantee that the Engineering and Technical Institute of British Columbia would be more Simon pure with regard to its membership, or that its members would be of any higher grade than those of any other society or institute. As a matter of fact, the secretary of one of the other Canadian technical societies alleges that the contrary proposition is more correct.

One phase of the object of the bill is being met by the present change in the Engineering Institute of Canada. Undoubtedly the public now finds its difficult to determine just who are the qualified engineers. The man in the street often finds the same difficulty, perhaps in lessened degree, in selecting a "qualified" doctor or lawyer. Leaving out of consideration the house-cleaning that would have to be done by any society which might want membership therein to be regarded as *prima facie* evidence of engineering ability, the public does not know what membership list or lists to consult. Injustice would be done to many well-qualified engineers by consulting only one or two lists. It would be obviously unfair, for example, to assume that an individual—because his name does not appear in the list of members of, say, the Engineering Institute of Canada—is not a qualified engineer. He may be a member of any one or more of a dozen other technical societies, and he may be fully qualified. But to make it easier for the public to distinguish in this regard, the idea actuating the men who are behind the broadening out of the Engineering Institute of Canada, is to widen the Institute to such an extent that it will include all qualified engineers in Canada, in whatever branch of the profession they may practice, and to weed out the few men now in the Institute who are not well qualified, so that ultimately a reference to the membership list of the Engineering Institute of Canada would be sufficient for all "persons requiring professional aid."

The committee of the British Columbia legislature showed good judgment in reporting against the bill. The best interests of the British Columbia public will be served by the growth of the Vancouver and Victoria branches of the Engineering Institute of Canada.

TO THOSE NOT INTERESTED IN ROADS

"EVERY engineer is, or should be, interested in every other engineer's problems, whether they are his own at the immediate moment or not," recently said H. H. Vaughan, president of the Canadian Society of Civil Engineers. Perhaps we are depending too much upon Mr. Vaughan's theory in devoting this whole issue to the Canadian Good Roads Congress, but we appreciate the advisability of presenting these road speeches to our

readers while they are still warm and pulsing. We trust that those engineers who are mainly interested in waterworks, structural or other problems, and but incidentally interested in roads, will be indulgent this week. Their turn to monopolize an issue with their particular specialty soon may come again as in the past.

PERSONALS

J. W. SHACKLETON has been appointed city engineer of Chatham, Ont.

ALEX. McKINNON, town engineer of Glace Bay, N.S., has resigned to accept a position in the State of Ohio.

STACEY H. OPDYKE has been appointed manager of the water sterilization department of the Northern Electric Co., Limited, Montreal. Mr. Opdyke has been in touch for a number of years with the treatment of water for various purposes. He is a graduate of Purdue University, and was formerly with the sales and engineering departments of the Dearborn Chemical Co. Mr. Opdyke's connection with the Northern Electric Co. is the result of that company's having recently secured the sole agency for Canada for the R.U.V. Co., New York. The latter concern are manufacturers of ultra-violet - ray water sterilizers, of which a few small installations have already been made in Canada for industrial purposes. Mr. Opdyke intends to endeavor to introduce the R.U.V. system for municipal water sterilization in Canada, a fairly large municipal plant having been recently installed at Henderson, Kentucky, with good bacteriological results.

D. DARRACH, Schomberg, Ont., has been appointed engineer on grading work for the county roads in York County, Ont.

Col. C. N. MONSARRAT, chairman of the board of engineers, Quebec Bridge, has been appointed consulting railway engineer to the Dominion Government, succeeding the late Sir Collingwood Schrieber. The offices of the board of engineers, Quebec Bridge, will be removed from Montreal to Ottawa, where its work will be completed.

A. B. MANSON, city engineer of Stratford, Ont., has received an appointment as lieutenant in the C.E.F. Engineering Corps. Mr. Mason, after graduating, spent a year in land survey work in the Northwest and a year and a half in railway construction with the Canadian Northern and the Mond Nickel Co. He has been in charge of the city engineering department in Stratford for the past six years.

Captain FRED. HARCOURT, formerly harbor engineer at Port Arthur, has been appointed assistant commander of labor units in France. Captain Harcourt, who is a son of Hon. Richard Harcourt, of Welland, graduated with honors from the University of Toronto in 1900. He went overseas in December, 1915, with the 94th Battalion and was promoted captain and adjutant prior to leaving for England. After acting as adjutant of the Canadian pioneer training depot for a time, he went to France in January, 1917.

GEO. A. McNAMEE, of Montreal, who is secretary-treasurer of the Canadian Good Roads Association, which held its annual meeting last week, was born August 20th, 1884, at Montreal. He was educated at the Archbishop's Commercial Academy and the Montreal Business College. After four years' clerical work in the traffic manager's office of the Richelieu & Ontario Navigation Co., he entered the employ of the Montreal Tramways Co., later becoming assistant to the secretary-treasurer. He was elected secretary-treasurer of the Automobile Club of Canada at its inception in 1905, and resigned from the Tramways Co. in 1912 to give more time to the club's affairs, as a million-dollar club house, garage and office building was contemplated. This scheme was abandoned, however, owing to the war, but may be taken up again after the war. He has organized two road congresses in Montreal and one each in Toronto, Ottawa and Hamilton.

ASPHALT PAVEMENTS

(Continued from page 450)

Medium sand for asphalt paving is one in which there is a decided predominance above the percent. required in the model grading of those sized grains that will pass a standard 40-mesh and be held on a standard 80-mesh sieve. The requirement of the model grading for medium sand is 43 per cent.

Coarse sand for asphalt paving is one in which there is a decided predominance above the percent. required in the model grading of those sized grains that will pass a standard 10-mesh and be held on a standard 40-mesh sieve. The requirement of the model grading for coarse sand is 23 per cent.

Medium-fine and medium-coarse are the terms applied to sands in which there is a decided predominance above the percentums required in the model sand grading for two of the sand grades. This quite frequently occurs, and it is in such cases that the standard grading is sometimes sufficiently approximated by the mixing of two instead of three separate sands.

Very fine sand is objected to by many on the ground that it usually makes an unstable mixture. In asphalt paving parlance, very fine sand is that which will pass a 200-mesh sieve but which is not fine enough to be considered dust or filler material. With some of the very finely pulverized fillers that are available to-day, we doubt if this objection is good.

Very fine sand is not filler, however, which was pointed out in a paragraph above, and it must not be allowed to be considered as such in meeting the standard or model grading for sheet asphalt paving mixture. If there is a serious amount of this 200-mesh sand in the sand aggregate, it should be added to the fine or passing-80-mesh-held-on-200-mesh material and deducted from the 200-mesh material in the mixture to make sure that the model requirement for 200-mesh material is properly met with inorganic dust filler material. Some specifications, very unfortunately, do not provide for this contingency.

(To be concluded in the next issue.)

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

DON RIVER BASCULE BRIDGE, TORONTO

Toronto Harbor Commission Erects Single Leaf Strauss Trunnion Bascule Over Don River at Cherry Street To Accommodate the New "Eastern Harbor Terminal District"—Some Details of Design and Construction

By GEORGE T. CLARK
Designing Engineer, Toronto Harbor Commission

As the reclamation work in the Eastern Harbor Terminal District, formerly called Ashbridge's Bay, in the city of Toronto, progressed to the point where industries were able to locate and traffic to this district consequently increased many fold, it became necessary to provide for the handling of this traffic by the construction of a modern movable bridge across the Don River Channel at the foot of Cherry Street, in the location shown in Fig. No. 3.

The temporary timber swing bridge formerly in use not only was inadequate to handle the increased traffic, but also, on account of its centre pier, greatly limited the size of vessel which was able to pass up the channel.

Before deciding on the type of new bridge best suited for the purpose, studies were made of several types of bridges, after which skeleton plans of the several studies were submitted to the builders of various types of movable bridges, with the request that they furnish rough plans and estimates of their particular type, together with methods and cost of operation.

After carefully going into the situation and considering all the circumstances in connection with the location, it was decided that the Strauss type of bascule bridge would be best suited for the Cherry Street bridge; consequently a contract was entered into between the Toronto Harbor Commission and the Strauss Bascule Bridge Co., Chicago, for detail plans and specifications, and tenders were called for on the basis of those plans and specifications.

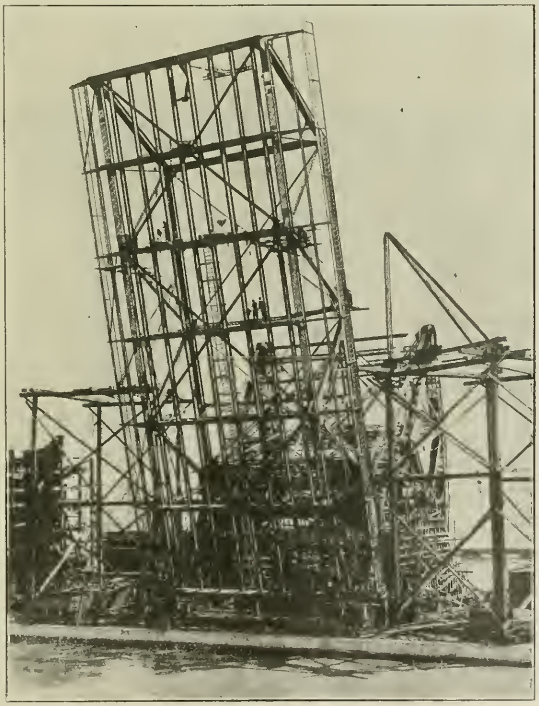


Fig. No. 1—Moving Leaf Erected in Its Open Position

The main foundations for the bridge consist of two main trunnion piers and two counterweight trunnion piers. The main trunnion piers consist of concrete cylinders, 6 ft. in diameter, resting on rock. The counterweight trunnion piers are of the same construction and are 8 ft. in diameter, also resting on rock. The method of construction consisted in driving 14-inch, arch-web Lackawanna steel sheet piling in a circle the inside diameter of which equalled the required diameter of foundation. This sheet piling was given two feet penetration in the rock. The excavation was then removed in the water with an orange-peel bucket. When the excavation was completed, the unwatering was commenced. As the water lowered in the cofferdam, pairs of angles, bent to the exact circle of the interior of the piling, were placed at intervals to prevent the collapsing of the forms. The concrete was placed in the dry. The angle bracing above referred to was removed as the concrete was brought up.

In the case of one of the cylinders, some difficulty was encountered in excavating. There was evidently a fissure in the rock not stopped by the sheet piling and the sand entered from the bottom as quickly as it was removed from the top by the bucket. The difficulty was overcome by plugging the fissure with clay.

Particular care was taken to see that all superstructure metal resting on concrete work was set to exact position and elevation. In order that the elevations of the bases

of the four trunnion posts would be exactly the same, the tops of the concrete piers were first brought up to an elevation approximately correct. Screed strips were then placed and any differences in elevation were corrected by floating with a 1 to 2 portland cement mortar.

In each trunnion pier there are four anchor bolts 1¾ inches by 6 ft. The value allowed for concrete in compression in these piers was 400 lbs. per square inch.

The total reaction per truss on the main trunnion piers is 680,000 lbs., and on the counterweight trunnion piers is 1,068,000 lbs.

The ballast walls or shore abutments of the bridge are as shown in Fig. No. 5. The elevation of the top of the Don Channel wall is 251.0, Toronto Harbor Commission's gauge; that is, taking mean sea level of New York Harbor as zero. The elevation of the crown of the roadway of the bascule bridge is 256.87. Hence it was necessary to raise the channel wall, for a distance equal to the width of the bridge, to a height of about 6 ft. above its former elevation in order to form the abutment.

The approaches to the bridge rise about four feet. The grade is an easy one on both approaches, but special attention had to be paid to the north approach on account of its intersection with Keating Street. The retaining walls to hold the fill in the approaches are of standard types and vary in height from that of an ordinary sidewalk curb to 6 ft.

Superstructure

The loadings governing the structural design of the bridge were as follows:—

Dead Load, the weight of the entire structure, including the floor system, rails, ties, guard timbers, pavements, handrails, etc.

Live Loads for trusses and floor systems:—

Electric railway, two 40-ton cars, class 20, Ontario Railway and Municipal Board specification.

Roadway, city bridges, class A, and road roller on floor.

Sidewalks, city bridges, class C.

Impact—All live load stresses, except those from road rollers or traction engines, were increased by an impact stress obtained by multiplying the live load stress by a factor derived from the following formulæ:

$$\text{Electric railway,}\quad I = \frac{130}{L + 150}.$$

$$\text{Roadway,}\quad I = \frac{100}{L + 150}.$$

L being the loaded length of the span producing the stress under consideration.

No impact was added to stresses produced by road rollers, traction or centrifugal forces, or wind loads, nor to any dead load stresses except as specifically mentioned for movable bridges.

All dead load stresses in members of movable bridges, towers, and counterweight arms and connections were figured for such positions of the structure as give maximum tensile and compressive stresses, and such stresses were increased by 20% for impact. These impacts were not taken in conjunction with the live load stresses and impacts.

Wind Loads—The entire structure was proportioned to resist a wind pressure of 15 lbs. per square foot on the exposed surface as projected on any vertical plane for any open position of the span; and for a wind pressure of 30 lbs. per square foot when the span is in its closed position. The machinery was proportioned for the maximum wind load on the basis of 15 lbs. per square foot, and the power was proportioned for the maximum wind load on the basis of 5 lbs. per square foot. Lateral systems of main trusses were proportioned for wind loads given for fixed spans where such loads exceeded the above.

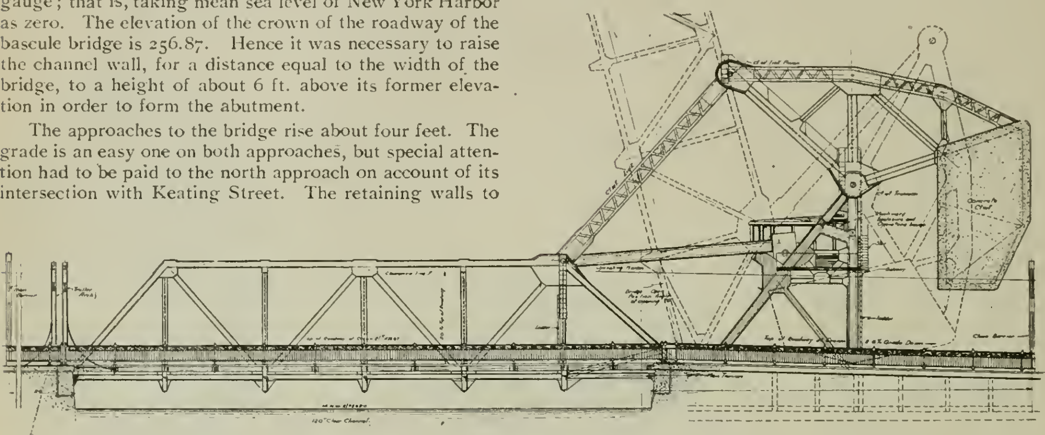


Fig. No. 2—Sketch Showing General Appearance of the Don River Bascule Bridge

The general appearance of the bridge is shown in Fig. No. 2. The moving leaf is a through Warren truss of six panels. The overhead clearance for traffic, from crown of roadway to top-chord bracing, is 20 ft. The length of the bridge, from centre line of main trunnion to centre line of bearing on the north abutment, is 130 ft., and the clear span is the full width of the Don Channel, namely 120 ft. The distance from centre to centre of truss is 45 ft., and the clear width of roadway, face to face of curb, is 42 ft. The roadway will have a double track street railway, 11 ft. from centre to centre of tracks. Sidewalks are 8 ft. wide, in the clear.

The wearing surface of the roadway consists of 3-inch Norway pine paving blocks, treated with 14 lbs. of creosote oil per cubic foot. These blocks are laid on a course of 3½-inch Douglas fir sub-planking, treated with 12 lbs. of creosote oil per cubic foot, and the sub-planking is laid on 6" x 9" Douglas fir cross-ties, treated with 8 lbs. of creosote oil per cubic foot, and laid flatwise, spaced 24" centres.

The requirements for structural and rivet steel and the allowable unit stresses are in accordance with standard bridge practice. All trunnions and pins are of forged steel having an ultimate tensile strength of from 70,000 to 85,000 lbs. per square inch. Bearings and pillow blocks are of cast steel having an ultimate tensile strength of

70,000 lbs. per square inch. All main bearings are grooved for lubrication and fitted with screw compression grease cups directly connected to the bearings. The diameter of the main trunnion is 11", and of the counterweight trunnion, 12". Particular care was taken that trunnions and pins were turned perfectly true throughout; that they were provided with a sufficient number of adequate keys; and that they were accurately aligned and set.

The total weight of structural steel is 876,500 lbs.; and of trunnions, pins and bearings, 38,100 lbs.

Chain barriers will be installed at each end of the bridge, protecting both roadway and sidewalk. Each barrier is balanced by counterweights, and they are operated by a 5-h.p. motor. The mechanism of each barrier is so arranged that the brake shoes are free from the brake wheel except when the barrier is down, protecting the bridge opening. This eliminates the danger of the barrier failing to work on account of rust. The barrier itself is elastic and is so constructed as to gradually absorb the shock of any vehicle striking it. Fig. No. 6 shows the general elevation.

The painting specifications required that all riveted work in contact, and surfaces not accessible for painting after erection, should be given two coats of paint before the parts were assembled. The paint specified was 12 lbs. of red lead and 10 oz. of lamp black mixed with one Imperial gallon of pure raw linseed oil. It was subsequently decided that in regard to the riveted work in contact, the number of coats be reduced from two to one, to lessen the possibility of loose rivets resulting from the burning of

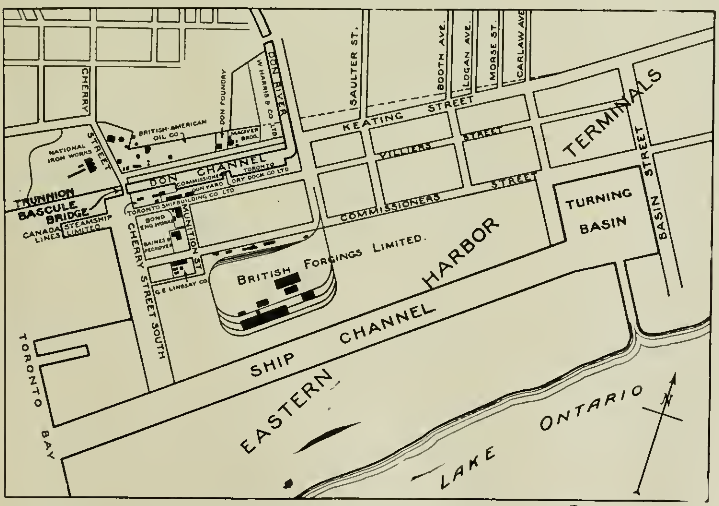


Fig. No. 3—Plan of Eastern Harbor Terminal District Showing Industries Already Operating There and Location of the Don River Bascule Bridge

the paint. All field rivet heads and all areas on which the shop coat was damaged, were given a coat of shop paint before the finishing coats were applied.

The bridge will be operated by electric power, delivered at the switchboard in the operator's house in the form of 3-phase, 25-cycle alternating current at 550 volts. Pro-

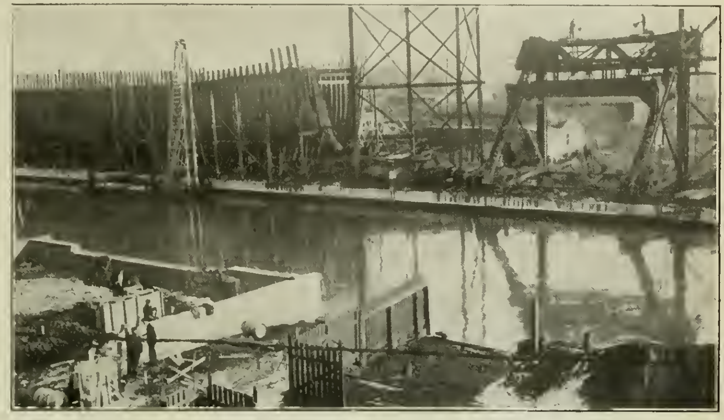


Fig. No. 4—North Shore Abutment in Foreground; Tower Posts of Counterweight Truss Erected Across the Channel

vision is made for taking current from either of two independent sources of supply.

The bridge leaf will be operated by two heavy-duty, enclosed type, variable speed, reversible electric motors, each operating at 710 r.p.m. with a normal running torque of 740 ft.-lbs. and a maximum starting torque of 1,600 ft.-lbs. The motors are capable of maintaining the above normal rating for thirty minutes without exceeding a rise of 75 deg. C. above the temperature of the surrounding air. They are capable of starting under, and of carrying for two minutes without injurious heating or sparking, the maximum starting torque specified. The entire insulation and rotating electrical parts are equivalent to the mill motor type. Each motor is furnished with a steel pinion of proper proportion to drive the operating machinery.

The end lock is operated by one 5-h.p. enclosed type, reversible motor, running at 825 r.p.m., with 30-minute rating. This motor is designed to permit of swinging the span through an angle of ninety degrees without spilling oil or becoming otherwise affected. Hinged manhole covers are provided for the protection of the end lock machinery.

Each motor is provided with a "Block" brake which is normally held in the set position by a spring with such force as to overcome from 80% to 100% of the normal motor

torque. All brakes are released by a solenoid and held in release when the motor is taking current. Means are provided for releasing the brake mechanically when the bridge is to be operated by hand.

The controller for operating the motors is of the standard drum reversing type, and is of sufficient capacity and resistance to control the motors properly without injury and without shock to the machinery when starting the motors and bringing them up to speed. It is capable of reducing the starting torque to 35% of the nominal rated torque.

A foot switch with spring release is located near the controller so as to enable the operator to keep the motor brake released after shutting off the current, if it be desired to allow the bridge to coast.

The switchboard is large enough to locate meters, switches, circuit breakers and fuses without crowding, so that each device can be safely and quickly reached and operated.

Signal lights, meeting the requirements of the Dominion Government for bridges over navigable streams, are provided on the moving leaf and also on the abutments on each side of the channel.

On the north end of the bridge two contacts are provided, one to operate the chain barrier and the other for the two pier lights on this abutment. These contacts link up the operator's house with two solenoid relays which in turn engage a separate power service for the north abutment chain barrier and lights.

For emergency operation there will be installed a two-cylinder, vertical, self-contained gasoline engine capable

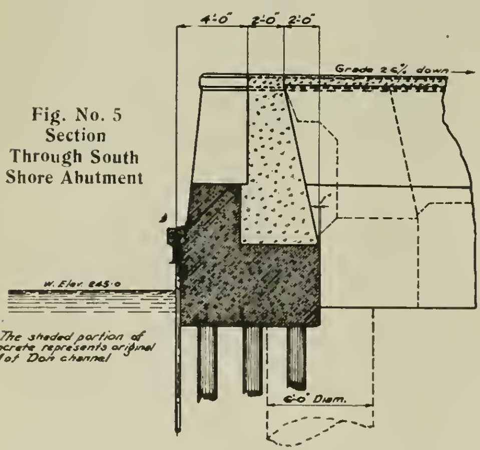


Fig. No. 5 Section Through South Shore Abutment

of developing 18 h.p. when operating at a speed of 800 r.p.m. The engine will be started by compressed air. Dust-covers and guards are placed over all gears in the machinery enclosure.

The operator's cabin and machinery enclosure is erected on the steel superstructure above the roadway. Hatchways were provided in the floor of the cabin for the removal of parts requiring repairs.

Counterweights

The counterweights consist of concrete, composed of one part of portland cement, three parts of sand and five parts of broken stone, gravel and iron ore. The stone and iron ore were so proportioned that the concrete, when dry, weighed 173 lbs. per cubic foot. The proper proportions, in order that this unit weight might be obtained, were determined only after considerable experimenting. Consideration had to be taken of the fact that a part of the water used in mixing the concrete united chemically with the cement, and part was given off in evaporation while the concrete was setting. Experiments showed that one cubic foot of concrete lost about four and one-half pounds in weight during the first ninety days, and that

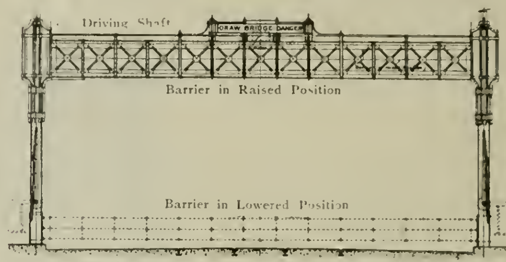


Fig. No. 6—End Elevation Showing Chain Barrier

the proper proportions of stone to iron ore, in order to obtain a weight of 173 lbs. per cubic foot of dry concrete, were 1 to 3 by weight.

Adjusting compartments, capable of holding 65 cu. ft. blocks of concrete when half-filled, were left in each counterweight. According to the centre of gravity calculations, the weight of the counterweight proper plus the weight of these additional blocks was just sufficient to balance the moving leaf. In case the unit weight of concrete varies, there is a working margin of approximately six tons in the adjusting compartment of each counterweight. The total weight of each counterweight is approximately 700,000 lbs.

The assembly of the steel has been completed, and riveting gangs are rapidly covering their end of the work. One concrete counterweight has been poured and the forms are being constructed for the other. The operating machinery is partially installed, and the operator's cabin and machinery enclosure are well under way. As can be seen by the photographs, the bridge is being erected in its open position.

The substructure, including trunnion piers, shore abutments and retaining walls, were built by the Harbor Commission's construction department. The contract for the superstructure was awarded to the Dominion Bridge Co., Limited, whose tender was lowest. The concrete counterweights are a sub-contract to the Raymond Construction Co., Limited, Toronto. Robt. W. Hunt & Co. Limited, attended to the mill, shop and field inspection.

Estimates of the Federal Department of Railways and Canals include $500,000 for construction of the Trent Canal; $1,860,000 for the Welland Canal; $43,000 for improvements to the Ontario-St. Lawrence Canal; and $700,000 for construction work on the Quebec Bridge.

Toronto is going to get $150,000 for the continuance of the Dominion Government's part of its contract in regard to the Toronto harbor work. Though the delegation which was in Ottawa a week ago, urging that the government live up to its share of the covenant, did not get much encouragement then, it is learned that the subject has since been before the Cabinet and that the justice of the city's claim is conceded. The supplementary estimates, it is understood, will provide $150,000 to be applied mainly to the protection of the work already done by the city and the government, so as to prevent it being damaged by ice or storms.

MANITOBA ENGINEERS' WAR COMMITTEE

At a special meeting, held April 22nd, in Winnipeg, the Manitoba Branch of the Canadian Society of Civil Engineers appointed a "War Committee" to promote in every possible way the co-operation of engineers with the military authorities, in order that the engineering and construction man-power of Canada may be used in the war with the utmost effectiveness.

The members of the committee are Harold Edwards, consulting engineer, who is the convenor; J. G. Legrand, bridge engineer, G.T.P.; D. T. Main, works manager, C.P.R.; Guy C. Dunn, division engineer, G.T.P.; and G. L. Guy, electrical engineer, Manitoba Public Utilities Commission. The committee has addressed the following letter to each of the members of the branch:—

"There is a great and increasing war demand for trained engineers and technical men. For any position in the service, the man whose civilian experience will be particularly useful must be found and given effective preliminary training for the peculiar and special conditions of active service. The right men for commissions must be discovered and helped along by special preliminary training.

Must Know What Material We Have

"Before the best system of training can be organized, we must know what material we have. The War Committee enjoins the earnest assistance of the members in order to make this inventory of the engineering man-power as complete as possible. Therefore, fill in the enclosed blank immediately.

"In addition to filling out the enclosed blank, the members should canvass their acquaintances who have had engineering or construction experience, and who are likely to be called in the near future. Knowing what the experience of the available men has been, preliminary training can be adapted to the needs of the greatest number.

"We have reason to expect instruction (from special instructors, who have seen active service in France) along the lines indicated on the inventory blank.

"Remember that the man of 55 can be trained to do work that in many cases will set free the man of 30.

"In view of our special training as engineers, it is our duty to strive to bring home to the minds of the people what this war really means. We must not forget that the German government has requisitioned every engineer, every chemist, every man, in fact, with technical experience of any kind, in order to utilize their special knowledge for the successful prosecution of the war, and for the winning of the great industrial struggle which must inevitably follow in its wake. Canada expects every man to do his best in the great cause, and this branch of the Canadian Society of Civil Engineers proposes to help to work out the methods of preliminary training that will prepare engineers to do their utmost whenever they are called. Therefore, give your country your leisure and enthusiasm. Fill out this blank and get others to fill one out also."

Questionnaire for Manitoba Engineers

Attached to the above letter was a questionnaire seeking the following information:—

"Name; birth date; married or single; if married, number of children; are you physically fit; what military experience and training have you had; in what lines have you had your best experience? Check off below:—

"Railway—construction, operation, maintenance or shops and rolling stock; general building construction; mining and quarrying; surveying and mapping; highways—construction or maintenance; electrical engineering—power and lighting, wireless, telegraphy or telephony; automobiles and motor transports—driving or repair; municipal engineering—sewer or water supply; machinery—manufacture or repairs; chemical engineering or analytical chemistry.

"What experience have you had as an executive in charge of men? Will you give two evenings per week for instruction and training that will fit you for more effective service?"

ENGINEER OFFICERS' PRELIMINARY TRAINING*

By J. G. Legrand
Bridge Engineer, G.T.P. R'y., Winnipeg

What help to the military authorities can the Manitoba Branch of the Canadian Society of Civil Engineers give by way of suggestion or actual service? That is the question which the present special meeting has been called to consider.

In January, 1916, I addressed to the general meeting of the Canadian Society of Civil Engineers a communication suggesting that they memorialize the government and offer their services along the following lines:—

"That the society should appoint an engineer of national standing, who should be their representative with the government. Whenever any question requiring special technical knowledge should arise, this representative should be called into consultation, and he immediately should put himself into communication with engineers having special knowledge along the lines in question."

If this suggestion had been accepted, all the members of the engineering profession would have been able to render useful service during the war, and not only millions of dollars would have been saved, but thousands of precious lives would have been spared.

It is just such an organization of technical skill that has proved Germany's strength during the present war. Every engineer, every chemist, every scientific man has been requisitioned by the German government and forced to devote his entire energies and special knowledge to the prosecution of the war.

All Trained To Do Almost Anything

In a free country like Canada, force would not have been necessary, but every individual would gladly have placed his services at the disposal of the government.

This offer was actually made. There appeared in *The Canadian Engineer* of January 4th, 1917, an article entitled "Engineers Will Offer Services." It appears from this article that Mr. O'Hara, Deputy Minister of Trade and Commerce, intimated that the government did not understand clearly just how engineers might like to help, and suggested to Mr. MacLachlan, secretary of the Canadian Electrical Association, that the engineers should get together and present some definite plan of action to the government. Mr. MacLachlan might have answered Mr. O'Hara that it is not for an officer to ask a soldier what he is willing to do, but that it is his place to command, and that he would find, in the case of engineers at least, that all have been trained to do almost anything, and that some of them could give useful lessons on organization and prompt execution.

*Abstract of address delivered at special meeting of Manitoba Branch, Can.Soc.C.E., April 22nd, 1918.

It is the duty of all Canadians, and especially those who have received special training, to concentrate all their energies so that Canada may do its full share in the crushing of the fiendish power which is threatening to overthrow civilization. How may this be done?

Experience has shown that the physical training of such large bodies of men as needed in the present war can only be obtained by long years of intense work. That means that the training must be begun in boyhood. This is so well known that in France it has been the practice for the last thirty years, to begin this training in the schools.

This training is so thorough that when a young man is drafted into the army he feels quite at home, and his body is so trained and inured to fatigue, that he can endure without hardship the intensive training which he receives in the army. It is not only the army that profits by this physical fitness, but when the young man reverts to civil life the entire nation benefits by it.

Thoroughly Equipped Along Technical Lines

A striking example of the benefit of this early training is to be found in the class which has been just drafted into the French army. According to competent military authorities, no body of recruits has ever been found so thoroughly fitted for military service. This has proved to be equally true for technical training, for the officers have not only shown that they were physically fit, but they have proved that they were thoroughly equipped along the technical lines required for the multitudinous services of a modern army. This result has been obtained by long and arduous special training in military schools, supplemented by actual experience on active service.

In France, as all know, military service is compulsory. Every young man of twenty who is physically fit is drafted into the army, and remains on active service for three years. He is then put on the reserve of active service for ten years; that is, until his thirty-third year. During this period he is called twice to take part in the general manoeuvres for twenty-eight days. He is then transferred to the territorial army for six years, and remains till his thirty-ninth year. During this period he is called once for thirteen days. He then passes to the reserve of the territorial army for six more years; that is, till his forty-fifth year.

Having been brought up myself under these conditions, I noticed how little attention was being paid to physical training in this country.

Advocating Compulsory Training

To remedy this defect, in Montreal, where I was stationed for eighteen years, I succeeded after several fruitless attempts, in having gymnastics introduced into the schools. The result was so satisfactory that after three years we were able to send a team, chosen after a competitive elimination from among several hundreds of young men, to Europe. This team won the first prize, and there were several individual prizes. Two or three years later, another team was sent to Europe and had almost an equal success.

A few years before the war broke out, at least 6,000 boys were taking physical training in the Montreal schools, and I have no doubt but that some of them have given a good account of themselves during the present war.

My great desire would have been to see this movement spread throughout Canada, and to have organized interprovincial competitions. Unfortunately, my removal from Montreal and more absorbing occupations prevented the realization of this dream. More than ever, at the present juncture do I believe in the opportuneness of this aim.

For the purpose of preparing men who are likely to be called in the near future, I would suggest, therefore, the immediate introduction of compulsory physical training for the men of Class 1 who are still to be called, the men who will be entering Class 1 within a year, and the men of classes 2 and 3; this physical training to be undergone at least three times a week, say, two hours at a time, outside of the ordinary working hours, especially by men who now lead comparatively inactive lives in banks, offices, stores, factories, etc.

In order to accomplish this, instructors could be chosen especially among the returned officers, non-commissioned officers and men who have distinguished themselves at the front, and who know by hard-won experience the value of physical training.

I would also suggest the immediate introduction of compulsory physical training in all the universities, colleges and schools of Canada.

Regarding the students who are at present taking engineering courses, I would suggest that the classes be continued all the year round in order to allow them to complete their courses before being called to the colors; thus enabling them to render the greatest possible service in engineering corps. I understand this has been done in the United States universities.

Now, as regards engineers proper, who at the present moment are in great demand at the front as officers of engineers, I would suggest that all engineers likely to be called should be immediately put through such a course of special physical and technical training as should enable them to discharge efficiently their very arduous and tremendously important duties at the front. It must not be forgotten that this war is eminently an engineer's war.

WOULD TRAIN WOMEN FOR DRAFTING, TESTING AND INSPECTION WORK

IN joint session on May 3rd, the Detroit Section of the American Society of Mechanical Engineers and the Detroit Engineering Society passed the following resolution:—

"Whereas the demands of the country for men and means to fight the war has resulted in a deficiency of skilled workers in the trades and professions; and

"Whereas the women of this country could with a short period of training fit themselves to fill these positions, as women have done in other countries at war; and

"Whereas among the things which women could do advantageously are drafting and tracing, inspection and testing of materials, both physically and chemically; therefore

"Resolved that the universities, colleges and technical schools throughout the land be asked to consider the question of meeting this demand by providing special courses of instruction open to women students qualified to pursue such courses; and further

"Resolved that employers who could use such skilled help exert their influence with their universities, colleges and technical schools, and co-operate with them in developing and making available a great body of intelligent and adaptable women who are as eager and willing to serve their country as their brothers;

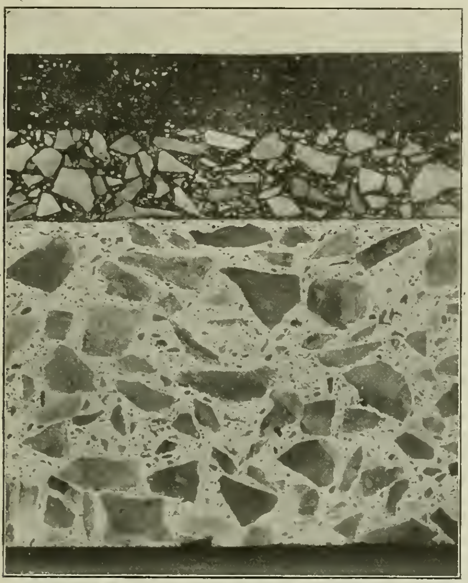
"Thereby bringing about not only increased effectiveness in fighting the war, but also a greater mutual respect and saner relationship of our men and women."

ASPHALT PAVEMENTS

By Charles A. Mullen

(Concluded from last week's issue)

STANDARD sand sieves are used in making screen analyses of asphalt paving aggregates, and not the commercial sieves that may be had on the open market at a low cost; though these may serve other purposes quite satisfactorily. Results on such commercial sieves are frequently as much as 20 per cent. off, and these results are of no value to the engineer making asphalt paving mixtures. The 200, 100 and 80-mesh sieves are particularly troublesome, and should be frequently checked for accuracy.



Sectional View of Sheet Asphalt Pavement, 1½-in. Wearing Surface on 1½-in. Close Binder on 6-in. Concrete Base

The mixing of three sands at the asphalt paving plant is not a difficult matter. At Saint Foy, in Quebec, last season, where the province was laying a "stone-filled" sheet asphalt pavement, we combined five grades of material in the mineral aggregate, exclusive of the filler, without difficulty. The various piles are arranged around the boot of the bucket elevator that feeds the heating drum, and then an intelligent laborer can be directed to feed so many shovels of this material and so many of that. A satisfactory result is secured in this way without additional expense other than possibly half a dollar a day extra to hold the interest of the man doing the feeding.

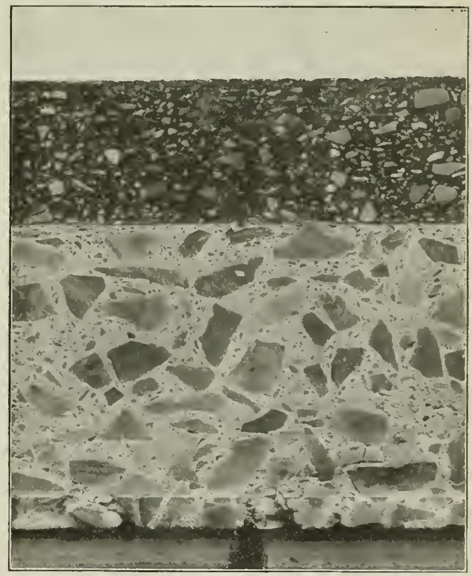
All sands are not suitable, even if a satisfactory grading can be secured. We must consider the shape of the grains, the character of their surfaces, the cause of the coloring, and any foreign matter that is present. Sands that are the result of the incomplete disintegration of rock, and contain lumps of fine grains, must be avoided.

The shape of the sand grains is of considerable importance. They should be neither too rounded nor too sharp, but irregular, with flattened sections on the sides. What is desired is an aggregate that will pack well and resist displacement under traffic. The reason for avoiding round grains is obvious; and a mixture, the sand grains of which are very sharp, is believed to suffer by the excessive scratching of the bitumen film of one grain by its neighbors.

The surface of the sand grains is of some moment in that a film of bitumen will adhere to some surfaces better than to others. A rough, pitted surface is superior to a smooth, glassy one; and sand of the former type will carry more bitumen to a given grading than a smooth-surfaced sand. For this reason, the proper bitumen content of a standard asphalt surface mixture is dependent principally upon the materials available for compounding the mineral aggregate.

The color of the sand grains may be due to a surface film of clay, lime, iron oxide or other substance,—easily removed by mechanical means in the laboratory,—or to iron in the chemical composition of the sand grains. In the first instance, the sand should be avoided as a possible cause of failure in the pavement; but, otherwise, there is no reason for not using a sand because of its color.

The sands for asphalt paving are to be found in almost every locality if one will only look for them. We were told they were not to be had around Montreal, but a survey of the country for fifty miles about uncovered abundance, some in the very deposits from which the city had been getting its supply. Later, the fine sand that had previously been neglected was found within the limits of the city of Montreal, and on city property at that. We have had the same experience with Quebec City and Quebec Province work; and recently J. A. Baird, city engineer of Sarnia, Ont., in following our suggestion that



Sectional View of "Fine Type" Asphaltic Concrete Pavement (Often Termed "Stone-Filled" Sheet Asphalt or Improved Topeka). 2-in. Wearing Surface on 5-in. Concrete Base

he search his own city, has found excellent grades of all the sands required.

The asphalt paving plant has never been more than a very crude machine at its best. Wherever possible, we are inclined to insist upon the standard type, especially the twin-plug mill mixer with a batch capacity of at least one thousand pounds and means arranged above for proportioning the materials entering every batch by the weighing of each material separately.

The mixers should be covered to prevent the loss of the very finest particles of the inorganic dust filler, which are very valuable in the pavement and costly to buy, and so that the mixer platform may be a place where one does

St. George Street, Toronto, sheet asphalt, laid 1912, photo 1917. No repairs to date

not hesitate to ask another human being to work. Most mixers are left uncovered, however, either because the owners do not appreciate the loss of material that is resulting or do not care enough about the men who must work around them. It is time cities required covers on all mixers.

Steam melted asphalt cement is never burned in the kettles, therefore direct firing should be avoided whenever possible and watched with great care where not avoidable. Precautions should also be taken not to maintain the asphalt in a molten condition for too long a period, as this will cause it to become harder and lose some of its ductility.

Asphalt cement in tank cars should be arranged for whenever possible. The material may usually be had cheaper this way, and is easier to handle. If there is not sufficient storage capacity at the paving plant, a small quantity of the cement in iron drums should be kept on hand in case of the delay in transit of one of the tanks. Asphalt plants cannot afford to stop work during the busy season, for the overhead expense is too high.

Thoroughly mix the aggregate before pouring the asphalt cement into the mill. The practice of putting in the cement before or at the same time as the dust is dangerous. The sand is hot enough before being combined with the dust so that after it has lost some of its heat to this cold material, the aggregate will still be of the desired temperature, and this original heat of the sand is too great for a thin film of asphalt cement to stand without damage. If the mixer is covered, there will not be this tendency on the part of the mixer man to put in the asphalt cement first to keep the dust from flying into his face.

All temperatures at the plant should be watched with the greatest of care, and reasonable uniformity should be insisted upon. The purchase of a few thermometers, enough so that one may be placed at every point where it seems desirable, may save the loss of a very large investment in burned asphalt pavement. Even the most experienced workmen will sometimes overheat the materials.

The analyses of the mixture should approximate as closely as is possible in good practice the following standard or model:—

	Model asphalt mixture.	Model sand grading.
Bitumen	12%	
Mineral aggregate:		
Sieve test.		
Passing 200-mesh	13%	*N%
Passing 100-mesh held on 200-mesh	13%	17%
Passing 80-mesh held on 100-mesh	13%	17%
Passing 50-mesh held on 80-mesh	23%	30%
Passing 40-mesh held on 50-mesh	10%	13%
Passing 30-mesh held on 40-mesh	8%	10%
Passing 20-mesh held on 30-mesh	5%	8%
Passing 10-mesh held on 20-mesh	3%	5%
Passing 8-mesh held on 10-mesh	0%	*N%
Totals	100%	100%

*For "N" read the words "Not over five."

The model sand grading is but the reduction to 100 per cent. of the 75 per cent. of the mixture model that is supplied by the sand aggregate free from dust filler.

An asphalt paving formula, to produce the approximation of the foregoing mixture, with the usual materials, would be as follows:

Asphalt cement, pure bitumen	120 lbs. or	12%
Stone-dust filler, 80% 200-mesh	150 lbs. or	15%
Sand, specially graded and mixed	730 lbs. or	73%
Batch of mixture	1,000 lbs. or	100%

Seaton Street, Toronto, sheet asphalt, laid 1908, photo 1917. No repairs to date

Hauling mixtures to the street is not attended with any very great difficulty. Cities should insist that the wagons be tight enough to prevent the material being dropped all along the route from the plant to the job. The rest may be safely left to the contractor or the manager of the city

plant, a minimum temperature for laying being provided as a check against poorly compressed work.

Whether wagons or auto trucks will prove more economical is always a local problem. The auto trucks are good for long hauls with steep grades, but there is frequently greater economy in the wagon for short hauls with flat grades. Provisions should be made for the rapid loading and unloading of either, but especially the automobiles. The writer remembers figuring on one job that it cost one cent a minute to have a horse-drawn wagon of three tons capacity stand for its load, and five cents per minute for a five-ton auto truck. After that we built a loading hopper.

One Cent Per Inch-Yard-Mile

Canvas covers on the trucks are very good at all times, and especially in chilly weather when the crust of the mixture would otherwise become too stiff for proper raking. They should be so arranged that there is a three-inch or four-inch air space between the cover and the load, as this not only saves the cover but also provides much better protection for the hot mixture.

"One cent per inch-yard-mile" is a good formula to remember when considering the cost of hauling asphalt paving mixtures. That is, it costs about one cent to haul enough mixture to lay one square yard of asphalt pavement one inch thick and weighing about one hundred pounds, on a street one mile from the mixing plant. Multiply one cent by the thickness in inches of the pavement, and that by the number of miles between the plant and the job. This is a rough and ready rule that should not be used as a basis for a bidding estimate, but it will help in quickly considering the comparative advantages of various available plant sites. It was the basis of a large asphalt hauling contract in New York City at a time when team hire was six dollars a day.

The mixture should be dumped on the street on some spot outside of where any part of that particular load is to be laid, and all of it should be handled into place for raking by upturning the shovel at the place of deposit. Asphalt mixtures should not be cast long distances through the air to scatter over the foundation upon which they are to be placed. This is particularly true of those mixtures ranging from stone-filled sheet asphalt to bitulithic, in which such a casting about is likely to cause serious segregation.

Laying Asphalt In the Rain

Painting abutting surfaces of headers, curbs, manhole and handhole boxes, and so forth, is an old custom, and, we think, a very good one. The asphalt cement used for this purpose should be the same as that with which the mixture is made, and sufficient of it should be applied to be effective. If this detail of the work is worth doing at all, it is worth doing well, and not in the skimpy, careless way we so often witness on both contract and city work.

Sweep the foundation clean before placing the surface upon it. The investment is too great to be endangered by the neglect of a detail that costs so little. The roughened concrete surface that is preferred for asphalt paving requires some care in sweeping to make certain that all the small depressions are reasonably free from dust and dirt and loose material.

Laying asphalt in the rain is not so serious a matter as one would at first suppose. Experience has demonstrated that sections of pavement laid during quite heavy rainfalls have lasted quite as well as other sections placed when the weather was more favorable. This is not a plea for selecting rainy weather to lay asphalt surfaces, but for the costly mixture that is frequently hauled to the dump because some inexperienced engineer thinks a little moisture from above during the laying will cause an asphalt pavement to fail. We do not recommend laying in puddles of water, however, and every possible precaution should be taken to avoid bad weather.

Levelling and raking mixture requires more skill and attention than it usually gets. The raking process should be a kneading into place with the tines of the rake so that about the same weight of mixture will cover each square inch of the foundation. Only in this way can a pavement be laid that will get equal compression under the roller and that will be of equal density throughout. We believe that the depressions in asphalt surfaces are frequently due to the further compression under traffic of those parts of the pavement that are spanned by the wide wheels of the asphalt roller at the time of laying. Certainly a roller riding on two dense knobs of mixture cannot properly compress the loose material between.

Asphalt Gutters Should Have Proper Rise

A true surface is essential in any good paving job, but especially is this necessary with asphalt, where every little fault may be seen so easily. Also, if there are no waves, there can be no rolls, and we often think that many surfaces displace partly because the original workmanship left the beginning of the wavy condition that later becomes so objectionable. A long straight-edge, ten feet or more, constantly in use, will do much for any paving job.

The straight-line crown is used more extensively each year with all types of pavements, but it has special advantages in the case of asphalt where there is so much objection to the little shallow puddles of water that form on the centre of other crowns directly following a rain storm. The purpose of the crown is to shed water, and it should be made to do that as effectively as possible with the least necessary drop from a horizontal line. One-quarter of an inch to the foot is sufficient where a straight-line crown is used and the surfacing work well done.

Gutters should be asphalted to the curb. There is no reason for placing a cement or brick gutter on an asphalt street. Whether of asphalt, cement or brick, the gutters should rise at the rate of one inch to the foot or better for the first two or three feet from the curb in order to form a decided dish that will confine the water in a narrow stream against the curbing instead of permitting it to spread several feet therefrom. If the same care had been used in forming asphalt gutters with the proper rise that was used in laying cement or brick gutters on asphalt streets, no one would ever have thought it necessary to employ the other materials. The flat asphalt gutters of early construction have much for which to answer. Proper gutters can be formed and compressed with a tamper, and an experienced roller man can get in to them effectively.

Make Needed Repairs Promptly

Lay asphalt to the street car rail wherever the street railway road-bed is good. Where it is poor, compel the company to make it what it should be, if possible. There is something very disfiguring about a ribbon of blocks along an outer rail on an asphalted street, and it is absolutely unnecessary in most cases. The way in which the asphalt promoters have persuaded cities to lay block pavements along car rails on asphalted streets, has always appealed to me as diabolically clever. These men know that whatever is laid will go to pieces where the rail construction is bad, and, by shunting it over upon the other material, they avoid the discredit that would, unavoidably, though unjustly, fall upon asphalt.

First construct, then maintain your asphalt pavements. They should not require any repairs for a number of years after laying, except where some defect in construction comes to light, but whatever they do need they should get. Repairs should be carefully made, with perpendicular edges and properly painted joints. An asphalt patch should not be left higher than the surrounding surface. If properly compressed in the making, there will be no sinkage under traffic that will require an allowance. Do not leave the surface higher than the car rails, manhole boxes, and so forth, against which it is laid. This has been tried and abandoned.

Three methods of maintenance for asphalt pavement surfaces should be considered. There is the simplest way, the cutting out of the defective section and replacing it with new mixture. The surface burner method has been used extensively, with fair results; and the remelting and remixing process has been successfully employed in many places. Needless to say, all three methods can be used to advantage in every large city, each being fitted to different conditions that are sure to confront the engineer.

Remelting Old Pavements

The remelting and remixing of the old surfaces has always seemed to the writer the one way that should be more carefully developed, with a view to the future maintenance of our asphalted streets. The re-use of the old material, which can be made as good as ever at little cost by remelting and remixing, with possibly a little added soft asphalt to rejuvenate it, will effect great economies in pavement maintenance over a period of years. The cost of new material is saved and the expense of hauling the old surface to a dump is avoided. The trucks must return to the mixing plant anyway, and they may as well carry a load of old asphalt surface as go back empty for the next load of mixture.

Asphalt is in its infancy as a paving material. Each year sees larger tonnages of it used for this purpose, and, as paving economy is more carefully studied by our public authorities, the very clear reasons for its extensive employment as a road surface material will be fully appreciated. The more universally it is used in any city, the more economically it can be handled.

A SIMPLE WAY OF DETECTING ORGANIC IMPURITIES IN SANDS*

By Prof. Duff A. Abrams and Oscar E. Harder

EXPERIENCE in concrete construction and numerous tests have shown that the appearance of a sand is not a safe criterion for determining its suitability for use in concrete. For example, a sand which appears dirty may be entirely free from organic impurities and give excellent results, providing the characteristics of durability and grading are satisfactory. On the other hand, many sands which appear to be clean are coated with organic impurities of a nature that will produce very inferior concrete.

Numerous tests have been used for determining whether or not a sand possesses the requisite cleanness for use in concrete. The most common tests which have been used for this purpose are the determination of silt, and the loss in weight resulting from heating the sand to a red color. The silt test gives a measure of the amount of fine material—generally clay or loam—which is contained in the sand, but furnishes no information as to the probable effect of such materials on the strength and durability of concrete or mortar made from the sand. Experimental work carried out in the Structural Materials Research Laboratory, Lewis Institute, Chicago, have shown that it is the presence of organic impurities of a humus nature that is responsible for the effects observed from using sand of this kind. This humus material usually comes from the over-burden of soil which is found in most sand pits; it may find its way into the sand in other ways. It has been pointed out by many writers that the detrimental effect of silt in concrete is not proportional to the quantity of silt in the sand. The explanation for this result lies in the fact that it is only the impurities of an organic nature that have a decidedly injurious effect in retarding or preventing the setting and hardening of the cement; consequently, a considerable proportion of clay may be present without producing any effect other than a reduction in the strength which may be expected from the change in the grading of the aggregate.

Researches carried out in the Structural Materials Research Laboratory at Lewis Institute have shown that a simple colorimetric test may be used for detecting the presence of organic impurities of a humus nature in sands. (It is seldom that organic impurities other than those of a humus nature are found in natural sand.) This experimental work was begun through the co-operation of the Laboratory and Committee C-9 on Concrete and Concrete Aggregates of the American Society for Testing Materials.

Two methods of testing for organic impurities have been developed: (1) An approximate test for field use; (2) a more exact method for use in the laboratory.

The laboratory method differs from the field method principally in that comparison is made with definite color standards (or bottles containing colored solutions).

Mix the Sand With Sodium Hydroxide

The field test consists of shaking the sand thoroughly in a dilute solution of sodium hydroxide ($NaOH$) and observing the resultant color after the mixture has been allowed to stand for a few hours. Fill a 12-oz. graduated prescription bottle to the 4½-oz. mark with the sand to be tested. Add a 3 per cent. solution of sodium hydroxide until the volume of the sand and solution, after shaking, amounts to 7 ozs. Shake thoroughly and let stand for 24 hours. Observe the color of the clear liquid above the sand. A good idea of the quality of the sand can be formed earlier than 24 hours, although this period is believed to give best results.

If the solution resulting from this treatment is colorless, or has a light yellowish straw color, the sand may be considered satisfactory in so far as organic impurities are concerned. On the other hand, if a dark-colored solution results, the sand should not be used in high-grade work such as is required in roads and pavements, or in building construction.

Washing sands has the effect of greatly reducing the quantity of organic impurities present. However, even after washing, sands should be examined in order to determine whether the organic impurities have been reduced to harmless proportions.

The test made in the manner described above will be found useful for prospecting for sand supplies, checking the cleanness of sand received on the job, and preliminary examination of sands in the laboratory.

This test is now being used by a large number of testing laboratories, engineers and contractors in passing on the suitability of sands for use in concrete. In certain instances the test has been made the basis of specification requirement for sand.

*Abstracted from article in Concrete Highway Magazine.

ALBERTA ENGINEERS DISCUSS ENGINEER'S STATUS AND PROPOSED LEGISLATION

PROPOSED legislation defining the status of the engineer, and the appointment of engineers to government commissions and offices, were the principal subjects discussed at a general meeting of the Alberta Division of the Canadian Society of Civil Engineers, held in Edmonton during the afternoon and evening of April 27th.

F. H. Peters opened the discussion on the former subject. He reviewed the steps which had been taken in the Calgary and Edmonton branches in the discussion of this subject up to the present time. He stated that it now appears that it will not be possible to secure Dominion legislation, and in view of that condition it is desirable to secure a provincial act which could be accepted by all the provinces, and afterwards if necessary, affirmed by the Dominion Government, thus providing a uniform law all over the Dominion.

A. G. Dalzell, of Vancouver, described the feeling of the British Columbia members of the society. He stated that when the matter was presented to the Vancouver Branch, some of the members claimed that legislation had been tried in two provinces and had been a failure. Objection had also been made on the ground that legislation meant a "closed shop," and the matter was further complicated because just at that time a certain group of engineers in British Columbia were asking for provincial legislation which had some objectionable features and which could not receive the support of the society. He believed, however, that legislation along the lines suggested by the Calgary Branch was now receiving favorable consideration. The entire question was fully discussed by a number of the members, the result being the appointment of a committee consisting of F. H. Peters, W. Muir Edwards and S. G. Porter to study the entire question, to draft a scheme of incorporation of engineers by provincial authority, and to report to the summer meeting at Saskatoon.

Sam. G. Porter, secretary of the Alberta Division of the society, opened the discussion on the appointment of engineers on government commissions. He called attention to the importance of the engineer's work in bringing about the necessary readjustment of social conditions due to the war and to the engineer's claim for greater recognition in appointment to positions of public service. He also outlined the efforts that the Alberta Division had been making to advance the interests of the society in this respect.

Abstract of Speech by Sam. G. Porter

"In the 'Literary Digest' for March 30th, 1918," said Mr. Porter, "an article appeared which described some of the unfortunate conditions which have arisen in the United States, and which that paper attributed to the employment of financial men instead of engineers in the direction of the production and transportation of war materials. As a result, says the article, a great deal of energy and enthusiasm and patriotic effort have been expended without, however, having them properly co-ordinated, and now they find that there is an enormous congestion of materials in some lines, far in excess of requirements or shipping facilities, and a corresponding shortage in others. It claims, however, that the ability of the engineer to organize and direct war production with a proper regard for the necessary sequence and co-ordination of the various processes, is being recognized and that the engineer is coming into his own. Let us hope that it is true; true not only in the United States, but also in Canada.

"It may be that engineers are largely to blame for conditions that now exist. Possibly they do not take the interest in public and political matters they should take; that they do not make themselves so well known as their importance in the community would justify. Is that the reason that among the four men considered by President Wilson for the important position of United States Railway Dictator, no engineer's name appeared? Is that the reason that for such offices as Minister of Public Works, or the head of a commission to report on the reconstruction of a destroyed city, or a commission to control the expenditure of public money on public utilities, our government seldom even gives thought to the idea of appointing engineers? Has not the engineer in this war demonstrated beyond dispute the importance of his profession and his right to proper recognition, not only in the prosecution of the war but also in other government and public service?

More Sound Development, Less Exploitation

"I think we all realize that in the social readjustment which will follow the war—which in fact is in progress even now—the business of the world is going to be handled on a more scientific basis than before, with labor having more voice and capital less dictatorial power, with the engineer and other scientists directing their efforts and adjusting their differences. Governments are often slow to recognize changed conditions, even where the changes are radical, and it becomes one of our duties both to ourselves and to our government, to interpret these social changes and insist that they be met in a businesslike way.

"Another condition which must be recognized is that the government is assuming more and more the control and operation of the resources and utilities of the country. It should, therefore, have the best business and technical ability of the country in charge of them instead of permitting professional politicians to blunder the job. Let us have more sound development and less exploitation.

"In insisting that the government should appoint engineers to public commissions and offices, we should insist also that they be good engineers, properly qualified for the work they are called upon to do; otherwise the end in view will be defeated and both the interest of the public and the prestige of the profession will suffer. It should be remembered that the duties of an engineer, particularly in public service, are often of a judicial character as well as technical, requiring sound judgment based on thorough training and experience. Engineers on their part should be prepared to assume these responsibilities, while the government on its part should provide remuneration adequate for such service.

"This phase of the question dovetails into the question of legislation for engineers. There is need of intelligent regulations to define a certain minimum standard in order to eliminate incompetents, create a high standard of service and inspire public confidence. The public is entitled to a knowledge of the fitness and capability of the engineers it employs. By having a compulsory registry, the government would be furnished with complete information relative to the special ability of every engineer in the country."

J. L. Cote, M.P.P., was asked to speak on the Civil Service Act in Alberta. He explained that an act had been passed by the provincial legislature providing for the appointment of an efficiency officer, but that the officer had not yet been named.

PAINTS—HISTORY AND PROPERTIES*

By Robert Job, A.B.
Vice-President, Milton Hersey Company, Ltd., Montreal

FAR back into history dates the use of paint for decorative and for preservative purposes; but in the brief time at our disposal we will consider only some of the most prominent types of modern paints and their most important properties.

Paint is described, in a general way, as the mixture of finely divided particles of solid matter called "pigment"

Fig. 1—White Lead Paint, Showing Chalked Condition

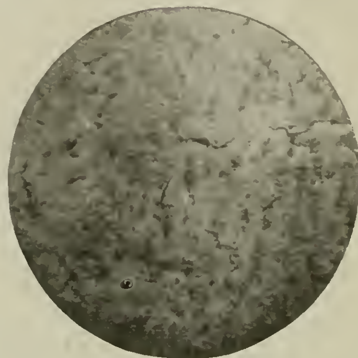


Fig. 2—Better Proportioned Paint After Same Exposure

in a liquid called the "vehicle." Asphalt paint is merely solid asphaltum dissolved in benzine or some other vehicle.

The pigment functions to hide the surface over which the paint is applied to resist the action of weather and wear, and to give color. The selection of the most suitable pigment or combination of pigments depends very largely upon the relative importance of these functions under the conditions for which the paint is intended to be used.

The vehicle functions as the carrying and cementing body, and dries and binds together the solid particles of pigment in somewhat the same way that Portland cement and water unite sand and broken stone to form concrete.

The types of paints best known are three, differentiated by the vehicles used to carry and cement their pigments. The most important are the oil paints; but the enamel paints are now used quite extensively and cold water paints are daily becoming more popular for interior walls.

Asphalt paint is really a varnish. The varnishes differ from the paints in that they do not ordinarily have a pigment; though occasionally a little is added to give color, and we then approach what is known as "enamel paint."

The oil paints consist of pigment ground in a paint mill with oil as a vehicle, to which is added a small proportion of Japan drier to cause a fairly rapid solidification when the paint is applied.

Linseed oil, which is pressed from flaxseed, is the best known vehicle used in the oil paints. Until recent years, it was employed for all the better paints of this type, but it has the defect that a film of it is readily penetrated by water.

Other vehicles, as substitutes and improvements, were diligently sought, because of this unfortunate non-waterproof property of linseed oil. Among others, fish oil, Soya bean oil, and corn oil have been carefully tested and successfully used under certain conditions, but the greatest advance has been made by using China wood oil.

China wood oil, when properly manufactured, is very resistant to water, and it is largely employed at the present time in the manufacture of both paints and varnishes.

The enamel paints consist of pigment ground in a vehicle of varnish, which consists ordinarily of gum or resin, oil and turpentine. The evaporation of the turpentine leaves the gum and oil as a strong cementing medium for the pigment. Some of these enamels are very serviceable and resistant to weather, and the coating dries with an excellent gloss.

Cold water paints consist of pigment combined with gum, casein, etc., that dissolves in water to form the vehicle at the time of application. The evaporation of the water leaves the gum to serve as the cementing medium for the pigment. Some paints of this type have very fair weather resistance.

White lead pigment is one of the oldest and best-known. It was originally made from pieces of metallic lead called "buckles" that were corroded to form the white powder termed "basic carbonate" and known as "white lead." This process is largely used at the present time, though other methods have been adopted to shorten the period required for manufacture and to improve the product. White lead, as first produced, is purified, dried and powdered before being sent to the paint mill.

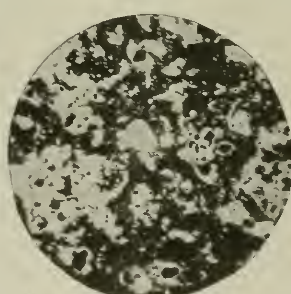


Fig. 3—Short-Lived Coarse-Particled Pigment Paint

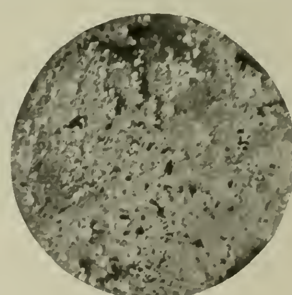


Fig. 4—Long-Lived Fine-Particled Pigment Paint

White lead paint, when the pigment is properly ground with an oil vehicle of good grade, has very great covering and hiding qualities. Unfortunately, it also has certain disadvantages. It is very poisonous and on exposure to weather it has the property of "chalking." When one's hand is rubbed over a board which has been painted with it for a year or more, the hand becomes coated with a white powder.

Chemical action between the white lead and the oil causes the change in a white lead paint film; and this

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*Lecture delivered as part of the Extension Course on Industrial Chemistry at McGill University.

action is so marked that in the course of a few years the house which has been covered with an excellent quality of white lead paint may be but poorly protected, especially if it is exposed to salt sea air.

Figure 1 shows the general appearance of this condition when examined with a magnifying glass, while Figure 2 shows the condition in contrast of a better proportioned paint subjected to exactly the same exposure and use.

Zinc oxide pigment is another which is well and favorably known. Owing to its non-poisonous properties, it is more desirable than white lead for interior work. This pigment used alone is also unsatisfactory as it produces a brittle coating that is likely to crack.

Other pigments commonly used are red oxide of iron, ochre, sienna, ultramarine, Prussian blue, chrome yellow, lamp black, and many besides, too numerous to mention.

Co-operation is as effective in promoting efficiency with pigments as with people, and by far the best results have been obtained with paints in which suitable pigments have been properly combined.

Little was known about the reactions between pigments and vehicles, or the reasons for good or bad service of paints made from given materials, until comparatively recent times. Certain bad combinations were shunned from sad experience. It was learned, for instance, that white lead paint mixed with ultramarine blue, will darken owing to the formation of black sulphide of lead, and that a sign coated with white lead paint will sometimes change from white to yellow within an hour if exposed to the sulphur fumes from a locomotive.

The study of paints was given great impetus about the year 1890, through the published investigations of Dr.

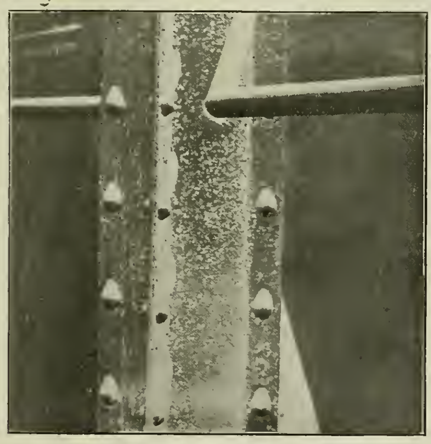


Fig. 5—Coarse-Particled Pigment on Upright Column, Fine-Particled on Horizontal Railing

Charles B. Dudley, for many years the able, widely known and respected chemist of the Pennsylvania Railroad. In his studies, among other things, the properties of paint materials were systematically investigated, and what was learned brought about radical changes in the composition and manufacture of paints.

The Pennsylvania Railroad gained much valuable information as the result of Dr. Dudley's work. It was clearly realized, for example, that the effectiveness of a paint did not by any means depend upon its cost per gallon or pound. As a matter of fact, it was proven that some of the most durable paints could be had at a minimum cost.

Other railroads were not slow to follow the lead of the Pennsylvania, one of the first to start on this work being the Philadelphia and Reading, now known as the Reading Railway. The results of some of these investigations were presented by the writer before the Franklin Institute, and elsewhere.

The size and form of the particles of the pigment were shown to have a great influence upon the life of a paint

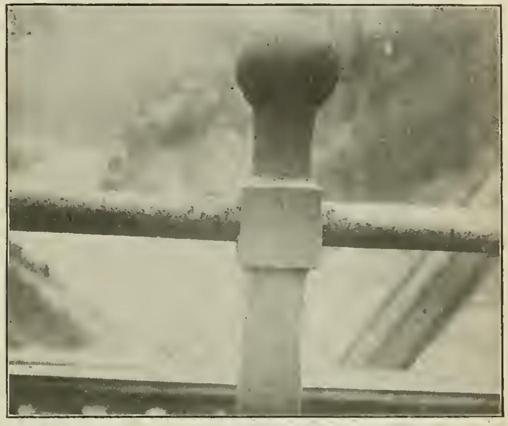


Fig. 6—Coarse-Particled Pigment on Horizontal Railing, Fine-Particled on Upright Post

coating, though this subject had not previously received any attention. A brief description of a case that clearly illustrates this point may be of interest:

Two bridge paints had been used upon the lines of the Reading for a period of about ten years. These paints were made by the same manufacturer, and contained almost the same proportions of the same materials. Though they were exposed side by side and under like conditions all along the road, one of them became known for its good service, and the other for very poor service. The life of one was twice that of the other.

The difference between the service rendered by these paints was so marked that we determined to get at the real causes, so as to bring the quality of all our paint deliveries to the same high standard of durability represented by the better paint.

The discovery that the main difference between the two paints was in the relative size of the particles of the pigments resulted from this investigation. In the long-lived paint, these particles ranged from two to ten ten-thousandths of an inch in diameter, with comparatively few of the maximum sizes; while in the short-lived paint the diameters ranged from two to one-hundred-and-eighty ten-thousandths of an inch.

The average diameter, as nearly as we could estimate, of the particles of the pigment of the satisfactory paint was four ten-thousandths of an inch, against eighty ten-thousandths of an inch for the unsatisfactory paint; and, as the volumes of spheres are to one another as the cubes of their diameters, it follows that the average particle of the pigment of the good paint was eight thousand times smaller in volume than that of the bad.

The composition of these two paints was about 25 per cent. oxide of iron combined with inert matter, such as clay and gypsum, as a filler, ground in pure linseed oil,

with a small proportion of Japan drier, as a vehicle. The details of the investigation may be found in the Journal of the Franklin Institute for July, 1904.

The reason why this difference in the size of the particles of pigment makes so marked a showing in the service of the two paints is that where the particles are coarse, relatively large oil spaces surround them; and as linseed oil is by no means waterproof, as we have mentioned, the effect of the weather is soon noticed in such paints.

Surface tension also operates in favor of the paint having the finer-particled pigment, on the same principle that causes fine sand, when wet, to hold together, where coarse sand or gravel will not.

Figure 3 shows the appearance of a paint film of the short-lived coarse-particled pigment, and Figure 4 shows that which had fine-particled pigment and was long-lived.

Fine-Particled Pigments the Best

Figure 5 shows a portion of a bridge after the paints upon it had been exposed for four years. The upright column had been coated with the bad paint, and the horizontal railing with the good. Figure 6 is another part of the same bridge in which the upright post was coated with the good paint and the horizontal railing with the bad. In both pictures and in both positions, the paint with the fine-particled pigment is seen to be in good condition, while the other is not.

These tests demonstrated that some of the most durable paints were composed of the simplest and least expensive of pigments, and created a good deal of interest because the findings ran counter to the preconceived ideas of many who had assumed that in order to be really good and give long service a paint must be composed of one of the more expensive pigments, such as white lead, and that those which contained the so-called "inert materials" were to be looked upon as "doped" products.

Because of misbranding and wholesale and indiscriminate adulteration, the manufacturers were in some cases to blame for this. For example, we have seen a supposedly oil paint that contained 30 per cent. of water. Another paint labelled "pure white lead" contained no white lead. Many other cases could be cited, and it is small wonder that such abuses led to a public outcry and legislation that was sometimes carried too far.

It became necessary, because of these conditions, to determine the truths about the properties and characteristics of the different paint materials, and the work was finally undertaken by the Scientific Section of the Paint Manufacturers' Association of the United States.

Experimental Iron and Steel Panels

A fence was built at Atlantic City, and several hundred panels were coated with paints of different formulæ in order to determine the value under exposure to the weather at the sea shore of the more important materials used as pigments, and also to show the most durable combinations of the various pigments under such conditions. Exposures were made on both iron and steel panels as well; and, subsequent test fences were erected in other parts of the country in order to get varying climatic conditions.

The tests were made under the supervision of the American Society for Testing Materials, and a vast fund of information regarding the service value of various compositions and combinations was obtained. Materials that many considered as adulterants not long ago are now known to have a definite value in the design of high-grade paints.

Misrepresentation still exists under the stress of competition, but the general plane of the paint industry is distinctly better for the simple reason that the principles of manufacture, the relation between cause and effect as applied to paints, and the properties of paint materials are all far more thoroughly understood than was the case even at the beginning of the twentieth century.

It will be clear from what has now been said that in order to be serviceable a paint must be composed of a pigment that is of a character well adapted to the conditions under which it is to be used, that this material must be in the most effective physical condition, and must be carried in a vehicle which will form an effective bond between its particles and at the same time be as nearly weatherproof as possible.

The spreading quality is a factor that should be very carefully borne in mind when purchasing paints. That having the pigment composed of the most finely divided particles, other things being equal, will spread farthest.

Specific gravity is another important factor, and should be studied accurately by the purchasing agent who is buying by the pound. The paint of the least specific gravity will be the greatest in bulk; and it is bulk, not weight, that counts in determining the spreading capacity of paints.

The labor cost of applying the paint is usually far greater than the cost of the paint itself; and it is important to remember this as a special incentive for the purchasing of the most durable paint for the purpose.

Specifications for various types of paints were the natural outcome of all the foregoing investigations and experiments with paints and paint materials. Such specifications have been drawn by the writer and others to cover paints for use under many different conditions, and these can be filled by any manufacturer who is willing to give care and attention to the work. Some of them, in fact, now carry these preparations in regular stock.

Specifications Lead to Economies

By purchasing wisely, under carefully drawn specifications, real competitive prices that represent the true market value of the paint materials plus a reasonable allowance for the costs and profits of manufacture, can be secured.

Marked economies have been effected by some of the principal railroads and by many smaller users of paints, through lowered costs and increased service as a result of working along these lines.

Large purchasers know they can not afford to do otherwise than buy according to specifications specially drawn to cover the needs of the service. It would be much to the advantage of many of the smaller purchasers who use quantities that would warrant the small expense connected therewith, if they would do likewise.

Final testing is, of course, absolutely necessary, for it is useless to buy according to specifications, or even on promises, unless the paints actually delivered are tested to determine whether they are as specified or represented.

VISIT TO OTTAWA PUMP HOUSE

Through the courtesy of J. B. McRae, consulting engineer, Ottawa, and by invitation of the mayor and board of control of that city, the members of the Ottawa Branch of the Canadian Society of Civil Engineers and their friends, including ladies, visited the new city pumping plant last Saturday afternoon. The plant was shown in operation under various loads.

Letters to the Editor

Mr. Dick Answers Mr. Newton

Sir,—Owing to absence from Ottawa, the attack on my pamphlet, "Briquetting of Lignite," was brought to my notice only a few days ago. Were it not for the expenditure on this plant that is being undertaken by the Dominion, Manitoba and Saskatchewan Governments, I would not consider it necessary to refute Mr. Newton's erroneous statements and deductions.

Mr. Newton states that he is not a "coal-chemist" nor a "mining engineer" but that he speaks as a "member of the public, who has looked a good deal into the fuel situation for the last few months from a commonsense point of view," and that he has burned lignite through the whole of one winter.

Most people consider that lack of technical knowledge respecting a purely technical subject disqualifies a man from discussing such subject. Mr. Newton, however, does not share that opinion. Mr. Newton seems to think that the best man to settle a disputed point is one who does not know anything about it because he is not biased either way.

Before discussing the erroneous statements and deductions in Mr. Newton's letter, I desire to correct his misunderstanding of the position of the Commission of Conservation, particularly as a knowledge of certain basic facts will demonstrate that he had absolutely no ground for many of his gratuitous assumptions.

Over a year ago, the Research Council requested the Mines Branch of the Department of Mines to investigate the carbonized lignite briquetting process and to supply cost data respecting same. The report was prepared for the Mines Branch by Mr. B. F. Haanel, who, I understand, was assisted by an expert fuel engineer. The Mines Branch transmitted a copy of this report to the Research Council.

Later, Mr. R. A. Ross, on behalf of the Research Council, requested the Commission of Conservation to report on the "market" possibilities of carbonized lignite. I was instructed to prepare this report and a copy of same was transmitted to the Research Council. On page 13 there is an estimate of cost, of fixed charges, etc., for a 30,000-ton plant, based, I understand, upon data contained in the report made by Mr. B. F. Haanel to the Mines Branch.

The Commission of Conservation is in no wise responsible for any statements respecting the costs of construction or operating the lignite briquetting plant, nor has the Commission reported on the practicability or efficiency of such plant.

The Commission of Conservation did not recommend that $400,000, or any other sum, be expended on a briquetting plant, nor that such plant be constructed, and the Commission was not asked to make any recommendation. Any recommendations of this nature were, I understand, made by the Research Council.

The selection of the site for the briquetting plant and its construction and operation, and the selection of the process are entirely in the hands of the Research Council, and the Commission of Conservation has no responsibility in connection therewith and has not been consulted in any way respecting same. All basic data, respecting the foregoing, contained in my report were received from the Research Council.

Mr. Newton states that on page 13 of my report the cost of United States anthracite in Winnipeg is given as $9.50 to $10 per ton, and that on page 17 the same report shows the cost as $11.25 per ton, and that no dates are given as to what year these figures apply.

These statements are made in this form although it is clearly stated that prices on page 13 are for the two years, 1916 and 1917, and are "f.o.b. cars," whereas the prices on page 17 are for coal "delivered" and are, of course, prices prevailing at date of writing the report, which, as shown on page 3, was prior to October 24th, 1917. Why does Mr. Newton ignore this difference?

Mr. Newton objects to the freight tariff figures and quotes the higher tariff in force to-day. What he omits to state is that the tariff he quotes only went into effect one month ago. Is it fair criticism to quote a tariff that was not in effect till five months after my report was written?

With regard to the B.t.u. value of the Souris coal, nothing that Mr. Newton can say will increase it. The analyses are given on pages 20 to 23 and can be consulted by anyone desiring accurate information respecting same.

Respecting the ash content of the coal from the larger operating mines, I refer your readers to the analyses referred to above. These samples include the so-called black-jack, seams of clay, etc., referred to by Mr. Newton.

Respecting detailed costs for carbonizing, briquetting, etc., and data respecting the proposed plant, I refer Mr. Newton to Mr. R. A. Ross, from whom these figures were obtained. No allowance for the by-products was made in my report, as it was the purpose to err rather on the safe side than otherwise.

To take up all Mr. Newton's statements and treat them seriatim would require more space than would be justified, but I think enough data have been cited above to demonstrate that Mr. Newton should acquire at least a superficial knowledge of the subject he discusses before rushing into print.

In concluding this communication, I desire to voice a protest against the language used by Mr. Newton respecting a brother engineer. Under any circumstances the use of such epithets as "inconsistent, inaccurate, too vague to be of any service and misleading," "most extraordinary proposition I ever came across," etc., is inexcusable. It is doubly so when based upon an ignorance of basic facts that could easily have been ascertained had Mr. Newton cared to make the attempt, and when made by a man who states that he is not a "coal chemist" nor a "mining engineer."

WM. J. DICK, M.Sc.

Ottawa, Ont., May 11th, 1918.

Engineering Ethics and Salaries

Sir,—The writer was pleased to see in your issue of the 9th inst., a letter from Mr. Goldman criticising the code of ethics laid down by the Canadian Society of Civil Engineers, for it is certainly a glaring fact that the consulting engineers are the only ones provided for in the present code, whereas it is patent to all engineers that a code of ethics is very necessary for the guidance of the engineer-employees, perhaps more so than for the consulting engineers, even though it might not be accepted as a guide by a large number of employed engineers who are not members of the society.

Were we to look closely into the matter, we might find that it is this lack of ethics for the guidance of the employed engineer, that is keeping a large number from becoming members of the society. There is nothing so degrading and disgusting to an engineer when he is applying for a position where the usual request is made, "State salary expected," as to feel that he cannot consider what is a fair value for his services but must consider chiefly as his guide in answering the question, the lowest figure that some other engineer will offer his services for.

Mr. Goldman says that one of the main objects of the "Canadian Association of Engineers" is to raise the standard of ethics among the engineers in Canada. The writer takes it that he means both the consulting and employed engineers, and were it to do that alone, it would be worthy the support of all engineers. But why not go a step further and endeavor to form some rules that would assist in answering the salary question as mentioned above; some rule that would be a sort of general standard to measure the value of an engineer's services? For instance, take the position of a city engineer. Is it not possible to base, in a general way, a standard of remuneration by (*a*) the population; (*b*) the difficulties attending sewage disposal; (*c*) the difficulties of obtaining a pure and adequate water supply; etc.; or may there not be other and better ways that discussion would bring to light? Of course, the question of over-supply will be a great factor with many in deciding the remuneration to be given an engineer in return for his services, and this is a subject that will have to be considered very seriously in the near future.

How would it do for our colleges to publish a syllabus containing a comparative remuneration table, as follows:

Civil engineer—Transitman, $75 to $90; resident engineer, $100 to $125; division engineer, $150 monthly.

Locomotive engineer—$140 to $175 monthly.

Railway conductor—$130 to $175 monthly.

Brakeman—$125 to $140 monthly.

Boss carpenter—$180 monthly.

Boss mason—$180 to $225 monthly.

Such a table might not be a pleasing embellishment to a college syllabus, but it would present the naked truth.

WM. CROSS, M.Can.Soc.C.E.

Toronto, Ont., May 14tn, 1918.

Armor Plates in Concrete Road Joints

Sir,—While reading the various interesting articles in your issue of May 2nd, my attention was drawn to an article describing a series of recommendations decided upon by a committee appointed by the American Society of Civil Engineers.

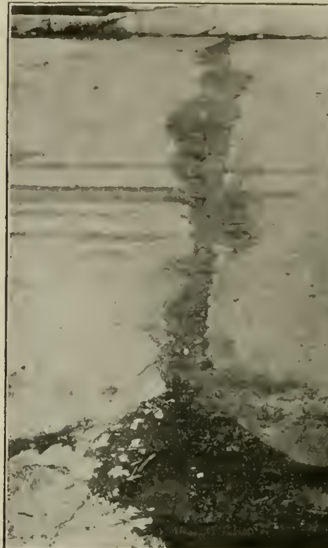
This committee was, I notice, appointed some years ago to consider the whole question of road construction, and in your article we have their findings.

The paragraph referring to armor plates at expansion joints is the one point to which I take strong exception, and I would like to ask those gentlemen if they ever compared an armored joint with an unarmored one a few years after the work had been executed.

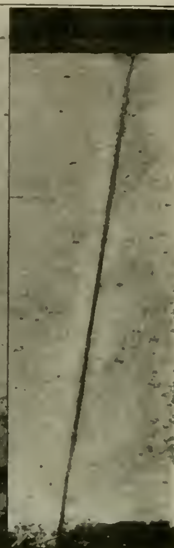
For the purpose of shedding light on the two methods of constructing an expansion joint, I am enclosing two photographs. Both these pavements were constructed in 1913, and are samples of numerous instances illustrative of both methods.

From my viewpoint, when forming an expansion joint, it is desirable to have and retain a perfect arris on both sides of the jointing material, and my experience leads me to the conclusion that this is impossible unless you have some form of plate.

There are, of course, plates and plates; but I submit that if the members of the committee had tried an armor plate properly designed and made from dead mild steel, they would, I venture to think, have returned quite a different finding. The photographs sent herewith are not by any means solitary examples. They can be found right here where the writer is located; both armored and unarmored joints may be seen, and a very slight study of the results ought to convince any engineer that it is economy to use armor plates.



Unprotected Expansion Joint. Note Reinforcement Showing Through the Broken Concrete



Expansion Joint Protected by Truscon Armor Plate

A. J. RIDDELL, A.M.Can.Soc.C.E.

Walkerville, Ont., May 15th, 1918.

"Canadian Association of Engineers"

Sir,—Will you kindly allow me space in your valuable paper to place before the engineers of this country the aims and objects of the "Canadian Association of Engineers," so far as the writer understands them. This association has been forced into existence by conditions as they have been in the past and are at present, and intends to carry on a progressive movement to meet conditions in the future as they arise, to the best interests of the engineer.

To remedy the present conditions in the engineering profession in such a manner that the effect will be to give the proper status to the engineer and place him on that plane to which he rightly and justly belongs, and gain for him the respect to which he is entitled and which obtains in the other professions, will require drastic measures.

Drastic is a hard word, and herculean efforts will be required, but the writer feels sure that an association especially formed to carry on this great and necessary work, not hampered by old conservatism, precedents and moss-covered ideas, can accomplish much.

The faith in an ideal, the strength of will to persevere to an accomplishment of that ideal, the vigor and audacity of youth, are great assets in the uphill fight to overcome the old idea that the engineer is a necessary evil (indeed, a great many consider him an evil whether necessary or not) in the commercial life of any country.

The fields of greatest need in which the association will be most active are at present four in number:—

First, the relation of the engineering profession to the community.

Second, the engineer in political life.

Third, the financial remuneration of the engineer.

Fourth, the establishment and maintenance of a service bureau.

This question of the relation of the engineering profession to the community is as vital to the non-professional man as to the engineer. It has been discussed to a very considerable extent by engineers of both the United States and Canada. The community is here taken to mean the local municipal centre as distinct from the larger centres, the federal and provincial parliaments.

R. O. Wynne-Roberts, in *The Canadian Engineer* of April 18th, tells us that Dr. G. F. Swain says, "The engineer is the advance agent of civilization"; and as the advance agent's business is the advertising of his organization, it follows that the engineer should advertise. Therefore a practical high order of publicity should be resorted to and the public made acquainted with engineering problems and their method of achievement.

The engineer and his organization in the different commercial centres could and should be collectors of statistics and all useful information. They should seek out and coordinate all facts appertaining to the problems of their city or district, and thereby become a central point to which each and every member of the community, the collective bodies as well as the individual, would of a necessity gravitate to seek help and guidance in the solution of their engineering difficulties.

Secondly, the engineer in parliament; and why not!

Is he inferior in intellect or intelligence? Is he less capable of using his special knowledge of the laws and forces of nature than his brother of the other professions? Why, then, does he not take his place on parliament hill?

The problems confronting this country are greater today than they ever have been in the past, and they are essentially engineering ones. Transportation, both lake and rail; conservation of power and fuel; mining and mining laws; these are the very elements of an engineer's existence. He lives in them; he lives for them; they are part and parcel of himself; yet in these he has been ignored, has been relegated to the minor positions, and has had to look on while other hands have been attempting that which is for them the impossible.

The new association will encourage the engineer to enter parliament and take his place, that of leader, in the forefront of the fight for the advancement of civilization. Surely the trained engineer, with his wealth of knowledge of engineering; experience of organization; keenness and faculty for hunting, classifying and co-ordinating facts; and habit of sticking with a thing till success crowns his efforts, would give better service as head of a department of public works, railways and canal, etc., than would a layman whose fertile brain is concerned mostly with after-dinner speeches and party politics.

The engineer's clean, wholesome mind, the sterling character derived from his close association with nature, would in a great measure tend to elevate the trend of politics in this country. It is inconceivable that an en-engineer at the head of a great public service department would advocate undertakings for which there was no justification for the sake of party welfare. It is abhorrent and altogether foreign to his being to make political playthings with the bounties of nature.

Thirdly, the financial remuneration of the engineer is an important object of the association and one that touches us all very closely at present. The engineer is the most poorly paid of all the professions, while his responsibilities are infinitely greater. The engineers, senior and junior, who designed and built the Quebec Bridge, the railways, the tunnels under the Hudson River, the tubes of London, and many other engineering enterprises, had on their shoulders the safety of more lives in one month than any member of any other profession has on his in a whole lifetime. Is not this responsibility of the highest order? Is it, therefore, fair and just to ask an engineer to accept a salary lower than that of the other professions or even trades? Rather the reverse, I should think.

An ex-counsellor or ward politician is foisted into a position with a large salary attached as head of a department which is essentially an engineering one, and employs engineers at small salaries to help him keep his head above water.

A certain municipality cuts in half the salary of its engineer and reduces his staff, thereby lowering the efficiency of the whole organization for the sake of "economy," while precious lives hang in the balance. There can be no doubt but that it should lie within the power of the engineering profession to regulate the degree of efficiency to the maximum of safety in any engineering department in this country, and not leave to the tender mercies of a non-engineer, matters of such vital importance.

Someone, the writer believes, has defined the engineer as one who can make a dollar do the work of two, but this refers entirely to his engineering problems and not to his wife's purchases of the necessities of life.

The remuneration for the services of those in other professions and trades has been steadily increasing during the last ten years; the salary of the engineer has remained at practically the same level for the last twenty-five years; which fact, together with the increased cost of living, has made it a very serious and difficult problem indeed for the engineer to make both ends meet and still retain his respectability.

Lastly, the establishment and maintenance of a service bureau is a very important move in the right direction and one which will meet with the approval of and be appreciated by all in the profession, both employers and employees.

The following absurd condition came to the writer's notice a short time ago and has since been confirmed: An engineer residing in Montreal had to apply to an engineers' employment bureau in Cleveland, U.S.A., for a position in his own city of Montreal, not four blocks from where he resided. At the present time there are no headquarters, no central point to which the engineer seeking employment may go to for information relative to his requirements or needs. He is like a ship without a rudder, drifting hither and thither, buffeted by wind and tide till by haphazard he gets a position. Generally he takes the first one he finds, whether he is likely to do justice to it or not. Maybe he will be a square peg in a round hole; but, discouraged by his endeavors, he seeks no further. Unsatis-

fied and unsatisfying, the service he gives will be directly proportional to his satisfaction in his new position, consequently the employer has a lower opinion of his abilities than he otherwise would have.

A service bureau where the experience and capabilities of the engineer are tabulated and indexed, where the employers could list their requirements, would tend to obviate this extremely annoying and unprofessional condition. The labor unions have their headquarters—the labor temples—to which they may go for news of the trade. Is the engineering profession too proud to emulate the good points of the trade unions?

Without such a bureau, the engineer seeking a position is to a certain extent restricted to the locality in which he resides, unless he is directly connected with the conditions and requirements of the profession throughout the whole country. Would not such a bureau tend to elevate the individual as well as the profession, and increase the value of the services rendered?

Mr. Stinson, speaking at a recent meeting of the Canadian Society of Civil Engineers in Toronto, said, "The engineer needs a selling agency for his services." A service bureau fills this requirement by bringing the employer and employee into close touch. Each may choose the other; both are satisfied customers; and satisfied customers are the essentials of good business.

FREDERICK B. GOEDIKE,
B.Sc., A.M.Can.Soc.C.E.

Toronto, Ont., May 16th, 1918.

CALGARY WILL SUPPORT CITY LABORATORY

LAST winter a resolution was forwarded by the Calgary Branch of the Canadian Society of Civil Engineers to the mayor, commissioners and city council of Calgary, requesting that in view of the very excellent work being performed by the laboratory of the city of Calgary under the able management of its chemist, F. C. Field, they grant their utmost support, financial and otherwise, to it.

The following reply from the city clerk has just been received by the secretary of the Calgary Branch:—

"I beg to advise you that council at its regular meeting, held on the 29th ult., adopted clause 6 of the report of the city commissioners of the 27th ult., as amended, and which reads as follows:—

" 'Re communication from the Calgary Branch of the Canadian Society of Civil Engineers re city laboratory. From what information we have received we find that the resolution of the Canadian Society was intended to bring more prominently before the city and the public generally the value of the city laboratory to this community, and to point out how it might further assist in advancing research work and future development of the city and province. It was pointed out to us that there have been a large number of failures in concrete work in the prairie provinces, which is costing governments, private and public institutions large sums of money. Investigations are being made by the Canadian Society of Civil Engineers and other organizations with a view to determining the cause and the remedies to be applied. There are also many other questions with regard to the economic utilizations of the provincial resources, and it is the wish of the Canadian Society of Civil Engineers that the city should lend its assistance through its laboratory and, if necessary, grant some small financial support in carrying on some experimental work which would be to advantage to this city and community.

" 'We, therefore, recommend that all support possible be given by this city to any legitimate research work that will be for the general benefit of our community. Any moneys necessary in this connection to be reported to the council.' "

THE PERSONAL PROBLEM OF THE ENGINEER IN WAR TIME*

By Edmund B. Kirby, New York City

WAR, tearing away the habits and formulæ with which we are accustomed to veil the fundamentals of existence, has set us face to face with these realities. In their presence trivial matters vanish and the questions, "What is my duty; am I doing it?" press themselves upon the soul of everyone. Whether they are but vaguely felt, or, on the other hand, are clearly defined, the demand cannot be evaded. Every man must justify himself to himself, and do it now.

But with the technical man, whose special distinction is a long training in clearness of thought, these questions are specially insistent, and yet strangely difficult.

In a war of engineering the men who apply science to the industries of the country and who direct the development of its machinery and processes, should be of peculiar value. Their knowledge and experience has a special fitness for the task in hand. Why, then, are not all such men, both young and old, taken from the non-essential industries and put into the war service of the government? In Germany every chemist, engineer and handler of men is assigned to the war work to which his special ability is best adapted.

While the enemy does this, we do not. With us a few distinguished specialists are invited to do certain things for the government, but the great mass of the technical men of the country are left to their own devices. They serve as usual in the commercial industries of the country, but beyond this their vast total of knowledge and ability has no means of expressing itself. As engineers and chemists they do not count. As ordinary citizens the young men go to the front, while older ones assist in bond selling, in Red Cross work, and in the many other public war movements, but as technical men their reserve capacity is unused.

Now, somebody must stay at home and furnish food, coal, steel, munitions, transportation, and, under the practical conditions of industry as it is now organized, the technical man usually finds himself doing these things at a more or less comfortable salary for a corporation which is making a more or less comfortable profit. No exception can be taken to his part in this. To care for his family, to pay his bills, and to lay up what reserve he can—these are the normal duties of every man. Why, then, do they not satisfy the engineer now? Why is he everywhere so uneasy, so discontented with his relation to the war?

How May He Satisfy This Obligation?

Is it not because he sees, whether vaguely or clearly, the difference between his position, proper as it may be, and that of the man who imperils the safety of his family and offers his own life in service at the front for $30 a month and expenses. For this difference is fundamental. It cannot be camouflaged to his own soul by the smug excuse that he is part of a necessary industry.

*From "Bulletin" of the Canadian Mining Institute.

Money-making and patriotism have nothing in common. One is material, the other sacred. One is self-interest—and the fact that the nation is often able to turn this self-interest to account does not alter its character; the other is self-sacrifice, that highest expression of duty, and to it the hearts of all men go out in reverence. Patriotism, then, requires that a man shall do something other, or something more, than the mere filling of his accustomed place in industry. The altar of one's country can receive only sacrifice.

The personal problem of the technical man is, therefore, a specially difficult one. How, with indifference on the part of his government, may he satisfy this obligation of honor in some way which will be effective? In this he cannot expect help from his government, because the latter is not sufficiently organized to consider such problems as making the most effective use of its technical men. The answer must come from these men themselves. Government has not the attributes of an individual. It is at best a crude and imperfect mechanism, efficient only in certain routine directions. Unfamiliar problems simply encounter a succession of ordinary men at desks, each harried by people to see and letters to write. The higher the position, the less there is of opportunity for consideration of new things.

But it is the genius of our race to be able to supply from below whatever lack there may be in the government above, and in doing this, technical men can obviously be most effective in co-operation with each other. The first step has naturally been the spontaneous effort to get as many as possible directly into the army and navy. The next has been the attempt to induce the utilization of selected specialists in civilian councils, boards, etc. But these measures have brought only a small percentage of the technical brains of the country into war service. Their vast reserve capacity is still practically untouched. To partly meet this situation a third step is now being taken in the United States, which is to bring war work to all technical men at their own homes, and for this purpose the technical societies have recently organized the War Committee of Technical Societies, which is just beginning its task.

War Committee of Technical Societies and Its Work

The work which the War Committee of Technical Societies has undertaken is to distribute war problems to the technical men of the country at their own homes, and to bring into action upon these problems the inventive ability of the country which is now latent.

By stimulating these trained men, over 100,000 in number, together with the wider circle to be also reached through them and by the aid of the journals, it is hoped to concentrate the attention of American inventors upon the matters which are most important and in which they can be most effective, and to aid them in the rapid development of their work.

The problems, selected from every available source, are to be prepared with the aid of specialists and issued to the membership (about 35,000) of the societies already represented, accompanied by such a presentation of the state of the art as will best interest and stimulate inventive ability. As rapidly as effective arrangements can be made, it is expected to reach the membership of all other technical societies, and also the general inventive ability of the country.

Certain kinds of war problems, such as those requiring secrecy and others relating to the development and perfecting of devices, require the most eminent specialists and the best equipment that the country can command.

Most problems, however, are suitable for general presentation to that vast reserve capacity of knowledge, inventive ability and equipment which cannot be identified and selected. The work of the committee, aided by the prominent specialists, is to bring this unknown capacity into action and to secure quickly the best it can furnish to the cause. This will be utilized in such ways as the government may direct.

The necessary trials and experiments will be conducted upon ideas and inventions which are of value. Ample funds for such purposes are available through the affiliation of the War Committee with the Naval Consulting Board, which is acting officially as a national board of inventions. All inventions which have successfully passed the necessary examinations and tests are turned over to the particular department of the Army and Navy Service where they may be most profitably utilized.

Collect Problems from Whole Allied Front

It is hoped that the technical societies of Canada, Great Britain and France may see their way to co-operate in this work by organizing in some similar way. The ideal which it is hoped to reach is the creation of joint machinery by which war needs and problems may be collected continuously from the whole front and within two weeks be in the hands of every technical man of the Allied nations.

But the above undertaking, important as it is, is only a partial solution of the personal problem confronting every man. The rest seems to be up to the individual and his own initiative. The essential difference between the professional man and the average man on the street is certainly not in the nature of their occupations. That of the laborer is just as important to society as that of the engineer. The vital difference, if one exists, must exhibit itself in their respective actions at times of public need.

If, with elaborate training and long experience in clear thinking, in the sense of responsibility and in the guidance of others, the engineer or chemist does not meet a crisis by showing more initiative than others, he is simply a useful workman, and not the superior citizen that his expensive training should have created. He cannot escape from being measured by the standards common to all humanity.

If, then, he cannot function professionally so far as he would like, he can at least show exceptional activity as a citizen. The sacrifice he substitutes for a personal appearance at the front will be money or service, or both, but it must be enough to hurt. As to choice, there are so many things which require doing: work to be found right at hand and undertakings at a distance. Those movements already under way need helpers, while unnumbered others wait for someone to initiate and to push them. The genius of the engineer is creative power, and there can be no better exercise of it than to start something.

Every Fault a Call for Somebody

Where things are going wrong, it is useless to point out what "They" ought to do. "They" means I. Every fault in the public machinery is a call for some individual to start the work of repair. Difficult as it seems for an unknown and distant man to affect large affairs, he can work apparent miracles in this direction by taking advantage of a certain sentiment, following a certain process and exhibiting a certain characteristic. The sentiment is the eagerness of others to assist in everything that will help to win the war. The process is the time-honored one invented by the old woman to get her pig to market, as

duly recorded in the chronicles of Mother Goose. The characteristic which completes the formula is plain, dogged persistence.

Never has the call to action been so insistent as now, when that hideous monster called Germany threatens every corner of the earth and everything that we hold sacred.

In the throes of parturition, a new and a better world is being born. By the touch of elbows on the long battle front, a new comradeship is being created, the union of everything that is good in humanity, for war to the end against everything that is evil. It is a comradeship which is extending back into the very souls of our nations, one which will eventually reach every class and touch every individual.

And, at last, through that power which sways the destinies of nations, the United States is coming to take the place of fallen Russia. Slowly, with many mistakes, with heartbreaking delays, we are coming, Canada!

THE NEW ERIE CANAL

LAST week the enlarged Erie Canal, connecting the Great Lakes and the Hudson River, was opened for traffic, though the formal opening will take place, with elaborate ceremonies, at a later date. The original canal, begun in 1817 and completed in 1825, had a minimum depth of 7½ feet. In 1903 it was decided to rebuild it on a larger scale, and $150,000,000 has been spent on the project.

The main channel is from Buffalo to Troy, 352 miles, and there are tributary canals to the Hudson from Oswego and Lake Champlain. In all, the State of New York will have 532 miles of canalized inland waterways. For the greater part of the distance, rivers and lakes have been utilized. Between Buffalo and Troy there are lift locks with a total lift of 210 feet. In order to raise the water level, thirty-nine artificial dams have been constructed.

Despite the enormous outlay, the Erie will remain a barge canal, with a minimum depth of 12 feet compared with 23 feet in the new Welland Ship Canal which Canada is constructing. It is impossible to predict the extent to which Great Lakes traffic for the Atlantic seaboard will be diverted to United States routes by the deepening of the Erie Canal.

The attraction of a deeper waterway from Buffalo to the Atlantic seaboard via the Hudson River will be offset partly or wholly by the new Welland, which will take the largest class of freighters. But when cargoes have passed the Welland, there will be competition between the 14-foot St. Lawrence Canal system and the 12-foot Erie Canal from Oswego to the Hudson. If the results are unfavorable to the Canadian route, the deepening of the St. Lawrence Canals will no doubt be hastened.—(Editorial in the "Toronto Globe.")

Tenders are being called by the Department of Railways and Canals, Ottawa, for rebuilding of the lower entrance piers, Lock 25 and Lock 23, respectively, on the Galops and the Rapide Plat canals.

The Brantford, Ont., gas committee presented a report to the City Council recently calling for the securing of an engineer to investigate gas purification, the supply of gas available and the cost of an artificial gas plant.

The Turbine Equipment Co., Ltd., Toronto, Ont., have the contract from the Otis-Fensom Elevator Co., for a 50 horse-power motor-driven De Laval centrifugal pump, for use in connection with a hydraulic elevator, to be installed in the Bell Telephone Building, Toronto.

NEW ASSOCIATION SUSPENDS MEETINGS

AT a meeting of the "Canadian Association of Engineers," held last Monday evening at the Engineer's Club, Toronto, it was unanimously decided to suspend all meetings during the summer.

After there had been considerable discussion regarding whether the association should be purely Canadian or a branch of the American Association of Engineers, a representative of *The Canadian Engineer* who attended for the purpose of reporting the proceedings, pointed out that the aims and objects of the proposed new association appeared to be identical with those of the Engineering Institute of Canada. He summarized the manner in which the Toronto and Ottawa branches of the Institute propose to deal with some of the problems that seemed to be of greatest interest to the prospective members of the new association, and urged that the Institute be given a fair chance to show what it can do along the lines of increased pay, closed profession, employment bureau, national status, etc., before dividing the efforts of the engineers by the formation of another association. After thorough debate, this viewpoint was supported by H. W. D. Armstrong, Thos. Taylor, F. B. Geodike, C. E. Tilston and others.

F. B. Goedike moved that the meetings of the proposed association be suspended *sine die* but that the "constitution committee" continue its work so that the association will be in shape to resume its activities at a later date should the prospective charter members feel that the Engineering Institute of Canada was not fulfilling expectations. This was unanimously carried and the meeting was then immediately adjourned.

AT AMERICAN WATER WORKS CONVENTION

AMONG the delegates who attended the convention of the American Water Works Association, held last week in St. Louis, Mo., were the following from Ontario:—

R. L. Dobbin, superintendent of waterworks, Peterborough; W. H. Randall, waterworks department, Toronto; H. Hyman, superintendent of waterworks, Kitchener; W. E. Macdonald, waterworks engineer, Ottawa; C. D. Brown, Walkerville Waterworks Co., Walkerville; C. W. Schiedel, Waterloo Water & Light Co., Waterloo; Geo. Geddes, water commissioner, St. Thomas; Robt. Hicks, water commissioner, Peterborough.

The British Columbia Provincial Public Works Department inspection of the flood damages in the Bella Coola section shows that the necessary repairs and construction of roads and bridges will total about $66,000.

The Hydro-Electric Power Commission of Ontario, have awarded the contract for six De Laval single and multi-stage motor-driven pumps for the Ontario Power Co., to the Turbine Equipment Co., Ltd., of Toronto.

Supplementary estimates of the Federal government, tabled on May 20th, total $46,957,312. Railway estimates include the sum of $3,489,313 to acquire the Quebec and Saguenay Railway and $518,000 for the acquirement of a number of short railways located in the Maritime Provinces. Harbor and river votes include $386,000 for St. Charles River improvements, $250,000 for St. John, N.B., harbor, and $152,000 for Toronto harbor. There is also a vote of $175,000 for the construction of a bridge on the Canada Central Railway over the Peace River crossing, and $100,000 for Fraser River improvements.

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Principal Contents of this Issue

PRINTED COPIES OF PATENTS

SIR ROBERT HADFIELD, president of the Society of British Gas Industries and head of the great firm of Hadfield Limited, of Sheffield, England, in a recent address on patent law reform, made the following statement:—

"As an example of the antediluvian policy of our Empire on this question, an Englishman in this country cannot get a copy of a Canadian patent without sending to Canada, and even then he gets only a typewritten copy, as patent specifications are not printed there."

This condition of affairs in the Patent Office at Ottawa has been brought to the attention of the Minister of Agriculture, of whose department the Patent Office forms a branch, by Mr. Hanbury A. Budden, a well-known patent attorney of Montreal. Mr. Budden marshals some very strong arguments for the attention of the government, and it is to be hoped that his efforts will be successful.

The Canadian patent office has issued over 180,000 patents. Canada ranks seventh among the countries of the world in this respect. A copy of a British patent costs 8 pence, while the U.S. Patent Office sells copies at 5 cents each. A copy of a Canadian patent costs an average of over two dollars and can be obtained only after considerable delay.

In the U.S. Commissioner of Patents' report to Congress for the year ending December 31st, 1917, the following figures are given:—

"Printed copies of specifications and drawings of patents to the number of 2,511,082 were sold at five cents each, bringing to this office on this account $125,554.10. For 1,277,184 copies sold to libraries, the office received $1,612.50. The total received from the sale of copies of patents was $127,166.60.

"Copies to the number of 1,097,550 were shipped to foreign governments, and 142,640 copies were drawn for office use. The total number of printed copies of patents distributed during the year was 5,354,133."

These figures show that there is a great demand for printed copies.

The public is interested in the publications of patents because it has the right to know the terms of the grant of a monopoly in order to avoid infringement while the monopoly exists, and it has also the right to know what has become public property when that monopoly ceases.

The patentee is interested in the publication of patents as he would readily purchase a number of copies of his patent to assist him in exploiting his invention.

The patent office is urgently in need of printed copies, not only to supply the examiners' files, but also to fulfil an agreement with the U.S. Patent Office to exchange copies.

In Great Britain and the United States, the libraries in all the great centres contain copies of patents for reference. In Canada it is necessary to go to Ottawa to make a search, and even then the cumbrous typewritten copies, which are not properly classified, make a search difficult and tedious.

The Canadian Patent Act, as it now stands, provides for the printing of specifications and drawings subject to the approval of the Governor-in-Council.

Undoubtedly it will take a long time to print the 180,000 patents which have been already issued, but that is a matter for special consideration. There is no doubt, however, that the system of printing specifications and drawings should be adopted at once and thus prevent the increase of arrears.

Canada has reached such a stage in her development that she should endeavor to be among the progressive nations, particularly in matters that concern her intercourse with other nations. The present time of rapid industrial and technical advance demands a change from old methods which may have been suitable for a young country. The contrast between our methods and those of the United States is very striking. An earnest effort should be made to reorganize our primitive system and bring it up-to-date.

DISTANT CONTROL OPERATION

IN the design of the new hydro-electric generating station at Cedars Rapids, Iowa, a radical forward step has been taken in the elimination of operator's wages in a station of considerable size, without sacrificing complete control. The station consists of three 400-kw., 60-rev. per min., 2,300-volt vertical generating units, tied in to a system of which the main generating station contains about 20,000 kv.a. in steam turbo-generators. One striking feature is the entire omission of the usual governors, the waterwheel gates being motor-driven and controlled by contact-making ammeters. Each unit has its individual control panel, consisting of the necessary contactors and relays to connect it to the bus at the proper time. A motor-driven drum controller gives the proper time element between the different steps in the operation of placing the generator on the line. Any generator can be started either by a float switch when the pond level reaches the proper height or by a remote control button in the steam station. The starting of the first generator throws on the line the motor of one of the two exciter sets, and

the generator cannot be connected to the bus until the excitation voltage has reached the normal value. The waterwheel gates are then partly opened and the generator comes up to approximately normal speed. It is then connected to the bus without field through an iron-core reactance. Then a weak field is applied. Next it is raised to full normal value, and then the reactance is short-circuited. The contact-making ammeter opens the gates to full gate opening and the generator then carries full load in about forty seconds after either the control button or the float switch is closed.

PERSONALS

W. R. Worthington, engineer of sewers, Department of Works, Toronto, was successfully operated upon last week at the Wellesley Hospital, Toronto, for appendicitis.

Lieut.-Col. George G. Nasmith, director of laboratories of the Department of Public Health, Toronto, received the degree of D.P.H. (Doctor of Public Health) last week at the University of Toronto. Col. Nasmith, who returned from France where he was in charge for some time of British army sanitary work, passed the examinations for this degree with a high mark. Col. Nasmith is now entitled to the very distinctive letters of C.M.G., M.A., Ph.D., D.Sc., (an honorary degree conferred a year ago) and D.P.H. He was born in Toronto forty years ago and graduated from the University of Toronto in 1900. Since his return from France he has written a book on army sanitation work. Among other research work which he has directed since his return, were the experiments regarding the fertilizer value of activated sludge, which were described in a recent issue of *The Canadian Engineer* in an article by Col. Nasmith and G. P. McKay.

James Hunter, of Toronto, has discontinued the operation of the Hunter Structural Steel Co., Toronto, and has joined the Submarine Boat Co. at Newark, N.J., having charge of two ways.

R. P. Dryer, assistant sales manager, Canadian Allis-Chalmers Limited, Toronto, has resigned to accept a position in the Pittsburgh office of the Allis-Chalmers Mfg. Co., of Milwaukee, Wis.

James H. Spicer, recently chief draftsman and shop superintendent of the bridge department of Canadian Allis-Chalmers Limited, is now works manager for C. W. Hunt Co., Inc., West Brighton, N.Y.

C. Hayward, formerly of the city engineer's department, Sault Ste. Marie, Ont., has been employed by Morris Knowles, Limited, Windsor, Ont., in connection with the proposed construction of the Essex Border sewerage intercepter.

Morris Knowles, consulting engineer, of Windsor, Ont., and Pittsburgh, Pa., has incorporated his Canadian firm. Mr. Knowles will be president of Morris Knowles, Limited; Chas. W. Tarr, vice-president and general manager; J. M. Rice, secretary.

J. G. Seyfried, C.E., lately of the Lackawanna Bridge Co., and formerly structural engineer of the Grand Trunk Railway, Montreal, and at one time connected with the bridge department of the Canada Foundry Co., has been appointed structural engineer of the Submarine Boat Co. at Newark, N.J., and will have charge of all structural design.

F. A. Danks, who has been in charge of the field work at both the slow and rapid sand filtration plants at Toronto Island, has resigned from the works department of the city of Toronto to join J. B. Nicholson, Limited, Hamilton, Ont., in superintending the construction of reinforced concrete reservoirs, coal storage plants, grain elevators, etc. Mr. Danks is a graduate of S.P.S., Toronto, class of 1908.

J. H. Billings, B.A.Sc., University of Toronto, will read a paper on the "Strength of Cast Iron in Bending as Affected by Variations in Cross-Sections," at a meeting of the Ontario Section of the American Society of Mechanical Engineers, to be held next Monday evening at the Engineers' Club, Toronto. Mr. Billings' paper will deal particularly with the research conducted during the past year at the University of Toronto. The meeting will be attended by Mr. Rice, of New York, who is the general secretary of the society.

Capt. R. H. Nichols, formerly partner in the firm of Vandeleur & Nichols, electrical and mechanical engineers, Toronto, spent a few days in Toronto this week on furlough preparatory to leaving for India, where he has been appointed general manager of the Bengal Iron and Steel Co., Limited. Capt. Nichols enlisted within a month after the declaration of war and was attached to the medical corps. He has been in service for forty-four months in various positions, both at the front and in British Government departmental work. He has not been wounded or sick for a day since he left Canada. His former Toronto firm was wound up within a few months after the declaration of war, as Mr. Vandeleur also decided to enlist, and is now serving in France as a captain in the Army Service Corps.

OBITUARIES

David Webster, chief engineer of the Brantford waterworks system since its inception over 40 years ago, died at his home in Brantford on May 17th, as a result of gangrene. He retired from the civic service a couple of years ago, and was succeeded by his son.

James Boyd, C.E., resident engineer at Hamilton, Ont., for the Grand Trunk Railway, died Monday evening, May 20th, at St. Joseph's Hospital, Hamilton. Mr. Boyd had been ill with pneumonia for eight days. He was born in 1877 in Airdrie, Scotland, and was a graduate of Glasgow University. He was engaged in railroad engineering in Great Britain before coming to Canada seven years ago to join the Grand Trunk. He was an assistant engineer on the G.T.R. staff at Toronto for four years, then receiving the appointment at Hamilton. Interment was in Mount Pleasant Cemetery, Toronto. Mr. Boyd is survived by a mother and two sisters, all resident in Scotland.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Steel Water Tower of 500,000 Gallons Capacity

Erected at Stratford, Ont., by the Hydro-Elec.ric Power Commission of Ontario—Factors Governing Decision Regarding Location, Height and Type of Structure—Total Weight on Foundations, 2,755 Tons When Tank is Full

By A. S. L. BARNES, A. M. I. E. E.
Hydro-Electric Power Commission of Ontario

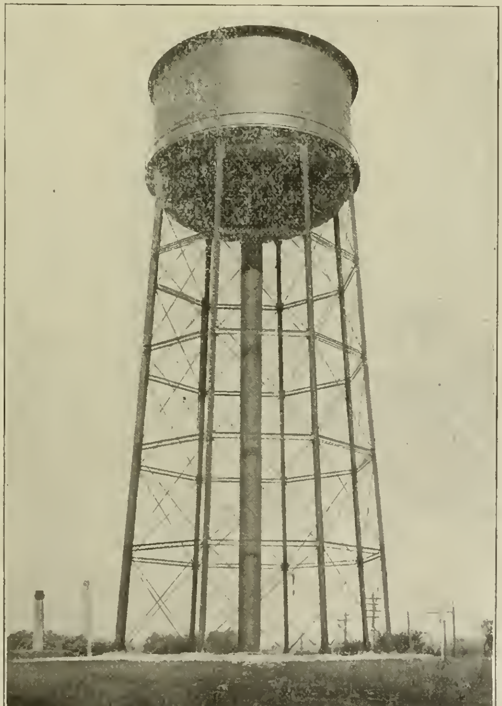
VERY considerable extensions and alterations have, during the past few years, been carried out in connection with the municipal waterworks department of the progressive city of Stratford, Ont., a place of some 16,000 inhabitants.

One important item on the programme of work done has been the provision of a steel water tower, of a height and capacity which are not exceeded in many places on this continent.

Like that of many another small municipality, the Stratford waterworks, prior to the installation of this water tower, pumped direct into the mains, a procedure which, as is well known, is not conducive to economy in operation.

A waterworks system run on this plan is like an electric generating station which, being without storage capacity, has to provide sufficient generating plant to deal with the maximum peak load and also requires some additional reserve capacity for use in case of emergency. The difference between the waterworks and the electric station, however, is that failure to provide suitable storage capacity in the latter case arises from physical disability; in other words, it is almost impracticable, except in the case of d.c. stations, and none too satisfactory there, while in the case of the former it arises either from financial disability, so far as the raising of the necessary capital is concerned, or from lack of mental capacity on the part of the authorities concerned to realize the benefits to be gained by providing it.

It will be well to review briefly what these benefits are. Suitable storage capacity, such that the maintenance of an adequate pressure at all times is assured, has the following advantages:—



Water Tower at Stratford, Ontario

1. More even pressure is obtained on the mains, giving better satisfaction to consumers, as well as better working conditions for the pumping plant.

2. Some reserve capacity is provided which is able to instantly take care of small fires (very many fires are checked by such means); even for larger fires the advantage of this immediately available capacity, if only at a moderate pressure, cannot be despised.

3. The operation of the pumping plant, from a financial standpoint, is greatly improved, because, in the first place, less plant capacity is required, thus reducing capital cost and overhead charge on plant, buildings, land, etc., and in the second place, the load can be maintained practically at a steady value throughout the twenty-four hours, or any desired portion thereof, resulting in increased economy of operation.

A little while previous to the outbreak of the war, it became apparent to the local waterworks authorities in Stratford that various changes should be made in order to comply with the requirements of the fire underwriters as revealed in their report. The matter was taken up with the engineering department of the Hydro-Electric Power Commission of Ontario and the whole question thoroughly gone into. The pumping requirements for fire service were considered but it is not intended to deal here with that part of the work. At the same time it was desirable that suitable storage capacity at some convenient pressure should be provided.

Local topographical features were such that a standpipe or elevated tank would furnish the only means of providing storage, with pressure, within a reasonable distance of the city's mains.

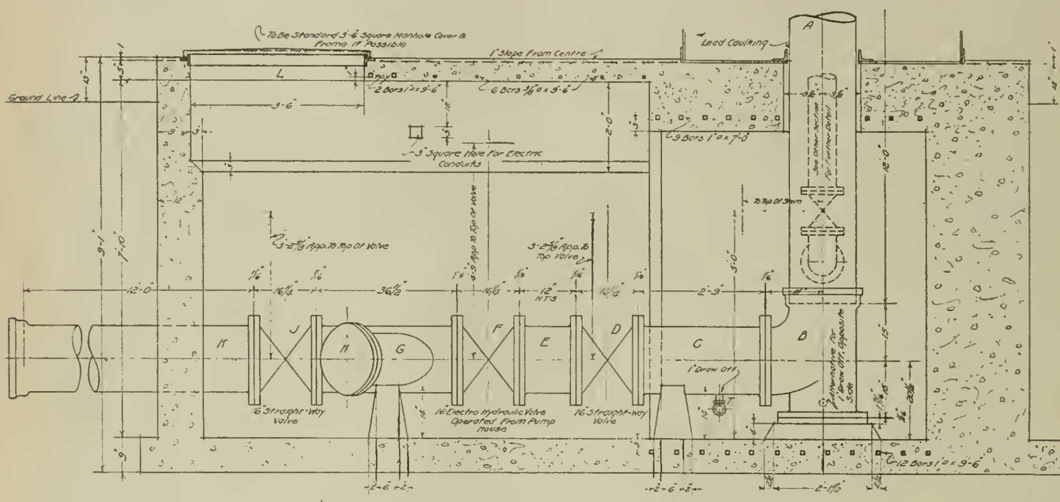
Since the cost of an elevated tank increases more rapidly than its height from the ground, it was evident that the site to be chosen for its location should be as high as possible, so that the actual height of the supporting structure should be a minimum; it was seen also that there would be advantage in having the tank fairly close to the pumping station.

Fortunately, quite near to the station is some rising ground, the summit of which is about 30 feet higher than the station itself and above most of the surrounding terrain.

It was therefore decided to locate the proposed standpipe or elevated tank at this spot and, as by this time it had been practically settled that 80 lbs. would be a suitable maximum pressure to be maintained, it was arranged that the actual elevation of the highest water level, when the tank was full, should be $(80 \times 2.31) - 30 = 155$ feet.

Very careful consideration was given to all of these—eleven in all—in order that their relative merits, both as to engineering features and price, might be properly appraised on an equitable basis. The tender of the Canadian Chicago Bridge and Iron Co., Limited, of Bridgeburg, Ont., was the one accepted.

The specifications called for the supply, delivery and erection of one circular steel tank of 500,000 Imperial gallons capacity, elevated on a steel tower so that the level of the water when the tank was full would be 155 feet above the ground at the base of the tower. The diameter of the tank is 54 feet and its depth 39 feet 9 inches; the bottom is elliptical, of such shape that expansion and contraction of the riser drum is effectually taken care of without an expansion joint. This bottom, being much shallower than a hemispherical one, also has the effect of appreciably raising the mean water-level.



Vertical Section Through Valve Chamber and Foundation for Riser Drum

A, length of c.i. bell and spigot pipe; B, special c.i. single sweep tee with blind flange; C, special length c.i. 16" pipe, flanged; D, 16" straightway non-rising stem gate valve; E, same as C; F, 16" electro-hydraulic valve; G, standard 16 x 16 x 12 c.i. Y piece, flanged; H, standard 12" c.i. blind flange; J, same as D; K, length of c.i. 16" pipe, flange and bell; L, manhole frame and cover, 3 ft. 6 ins. square; T, 1" brass angle valve, screwed ends.

The relative merits of stand-pipes and elevated tanks were considered; and since, in the former, a good deal of the water is practically useless owing to the pressure being too low, while the structure to support it must be provided just as in the case of an elevated tank, attention was concentrated on the latter.

The question of capacity was gone into and, after approximate prices on various sizes of tanks had been obtained, it was decided that storage for 500,000 Imperial gallons should be provided, partly because this quantity would be sufficient to meet requirements for some considerable time to come, and partly because the cost of the smaller sizes, per gallon, was found to be much higher than for the larger.

The four primary items of location, height, type of structure (*i.e.*, whether stand-pipe or elevated tank) and capacity having been settled, the question of steel versus reinforced concrete was raised.

Specifications for an elevated water tank were prepared and tenders were invited on both steel and reinforced concrete structures.

The supporting structure consists of eight legs built up of 14-inch "H" section columns with the necessary braces and stays.

The riser drum is of steel and is 6 feet in diameter; the idea of having one of such large size being to obviate the necessity of using any frost casing.

In connection with this large riser drum it was realized that at the bottom of the tank there would be an opening 6 feet in diameter with a sheer drop of some 115 feet down the riser drum to the ground and that this would constitute a serious danger to any workmen who, in repairing or cleaning the tank, might have the misfortune to lose his balance; it was therefore specified that this opening should be protected with a suitable iron grating.

In order that the riser drum might be conveniently connected to the water mains running out from the pumping station the specifications required a 16-inch pipe to be set vertically in the bottom plate of the drum, with an elbow at its lower end; this pipe extends about 5 feet into the drum so that sediment can settle around it at the bottom, a manhole being provided in the riser so that cleaning out may be readily done when required.

The tank has a conical all-steel roof, and also a steel balcony (incorporated with the circular girder which rests on the eight legs, and to which the tank itself is attached) entirely surrounding the tank, provided with a suitable railing and a ladder giving access from the ground, although, to prevent boys, or other unauthorized persons, from climbing it, this ladder only reaches to about 8 feet from the ground.

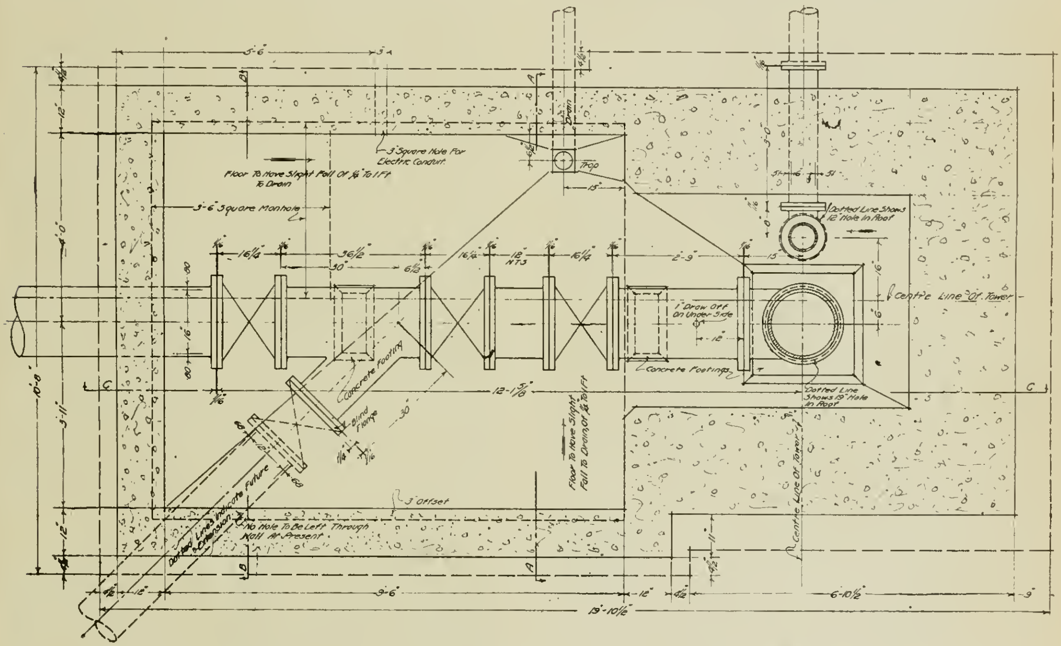
To enable the entire outside of the tank and roof to be conveniently inspected or painted, there is a revolving iron ladder reaching from the roof finial to the balcony; and, to provide similar access to all parts of the interior, a painter's trolley has been provided.

For the purpose of indicating the water level in the tank there is a pressure gauge in the pump-house and a float level gauge with a large, legible scale on the outside

Much consideration was given to the question of foundations for so ponderous a tower, and test borings were made to ascertain the nature of the ground in which the massive concrete footings would have to be set.

This ground was found to consist of approximately 3 feet thickness of clay on the top, underneath this being about 10 feet of coarse gravel, which gradually gets finer to a depth of about 20 feet. This gravel ridge extends to a sufficient distance horizontally to have warranted the assumption, which was made, that it would be safe to locate the tower on the spot selected. The foundations were designed for a maximum pressure on the soil of two tons per square foot.

The accompanying photograph of the completed water tower shows very plainly its great height and large size, and also the shallowness of the elliptical bottom. It is



Horizontal Section Through Valve Chamber and Foundation for Riser Drum

of the tank, and, in addition, an electric alarm whereby a loud bell in the pump-house is rung when the tank is nearly full or nearly empty.

In regard to painting, one shop and one field coat were specified, and for the interior of the tank special paint, suitable for that surface, has been employed.

The maximum unit stress in plate work does not exceed 12,000 lbs., with a joint-efficiency designed for 70 per cent. The compression joints are all milled and carefully fitted and there is sufficient number of rivets to carry 50 per cent. of the load at unit stresses consistent with the above. All metal in the structure is made to "Manufacturers' Standard Specifications."

The entire weight of the structure was estimated to be about 511,000 lbs., or over 255 tons, and actual weights later checked this figure closely. The weight of the water when the tank is full is 2,500 tons, so that the total weight on the eight concrete footings on which the steel legs rest, is a little more than 2,755 tons of 2,000 lbs. each.

easy to realize that the tower forms a good land-mark for miles around.

For the eight concrete foundations required to support the tower legs, 570 cubic yards of earth had to be excavated and 310 cubic yards of concrete were required. Each of the eight foundation piers is 15 ft. 6 ins. square at the base and 5 ft. square at the top. These piers are 9 ft. in depth and extend 1 ft. above the ground level. The anchor bolts are 1½ ins. in diameter and 6 ft. long.

Specifications for these foundations, and also for the valve chamber referred to below, were drawn up and tenders invited from firms located in and near Stratford. The contract was awarded to Messrs. Everitt and Marson, of Stratford.

In addition to the provision of the tower proper, with its foundations, it was necessary to construct a valve chamber, to accommodate, primarily, a valve required by the fire underwriters, capable of being instantly shut in case of fire, so that fire pressure could be put on the mains.

Besides this valve, which is of the electrically controlled, hydraulically operated type, there were installed two others—ordinary hand-operated, non-rising stem, gate valves—one on either side of it, so that, in case of trouble with the electro-hydraulic valve, there would be no difficulty in cutting it out and attending to it.

Figs. No. 1 and No. 2 show the lay-out, in plan and elevation respectively, of this valve chamber.

Excavation for this chamber amounted to about 62 cubic yards and the concrete required to 33 cubic yards; the large amount of concrete is due to the fact that one end of the chamber forms the footing for the riser drum, which on account of the great weight (= that of a column of water 6 ft. diameter and 155 ft. high plus the weight of the riser drum plus the compression, at times, on the riser drum, due to expansion) to be supported, is of necessity rather massive. Drainage, ventilation and lighting of the valve chamber are all suitably provided for.

Factory and field inspection of the whole of the work, at all stages, was arranged for by the Hydro-Electric Power Commission of Ontario.

The capital cost was approximately $30,000, this being somewhat augmented by the fact that contracts were let and the work carried on during war-time.

No figures are available to the writer as to the saving in cost of pumping effected by this water tower, but there is reason to believe that this has been appreciable, since the electric pumps can undoubtedly be operated under more favorable conditions, *i.e.*, they can be kept off the peak.

SIFTON ADVOCATES INTERNATIONAL DEVELOPMENT OF THE ST. LAWRENCE

Within a very few years there will be a demand for every horse-power that can be developed on the St. Lawrence River to which Canada is entitled for use upon the Canadian side, predicts Sir Clifford Sifton in the ninth annual report of the Commission of Conservation which has just been issued. "The situation with regard to Niagara will undoubtedly be duplicated," he declares, "and if we are foolish enough to allow vested interests to be created on the other side of the line, we shall inevitably find ourselves handicapped and embarassed as we now are with respect to Niagara power." He contends that a thorough study of the situation reveals that there is only one sound method of developing these powers, *viz.*, "an international commission under which the best use of the powers will be made, the most economical development effected and a just and equitable division of the power will take place for the benefit of the people who are directly concerned in its use."

Special prominence is laid in the report on power and fuel problems. Following a comprehensive review of the progress of conservation in 1917, by Sir Clifford Sifton, are addresses on "Peat as a Source of Fuel," by Dr. Eugene Haanel; "The Fuel Situation in Canada," by Fuel Controller C. A. Magrath; "Power Possibilities on the St. Lawrence," and "The Niagara Power Situation," by A. V. White; and a comprehensive treatment of the subject of railway electrification, by S. T. Dodd, of the General Electric Company, and W. F. Tye, C.E.

A full account is given of the work accomplished by the commission during the year in regard to water-powers, town-planning, mining, agriculture and game conservation. An interesting feature is a chart showing how the German buying combination controlled the metal markets of the world before the war.

AMERICAN WATER WORKS CONVENTION

(Special Correspondence)

St. Louis, Mo., May 20th.—Officers and members of the American Waterworks Association have reason to be gratified at the success which attended the thirty-eighth annual convention, held last week in this city. The war, the scarcity of materials, the shortage of labor, and the transportation difficulties are factors that to some degree must affect gatherings of men who are concerned with the design, construction and maintenance of waterworks plants. Nevertheless, more than 400 delegates and 200 guests registered, many of them arriving on Sunday afternoon, May 12th.

Waterworks Men Can Play Important Part

Monday, the opening day of the convention, was mainly devoted to registration and "getting together." The executive committee and the standing and special committees met at different times during the day. In the evening Mayor Kiel, of this city, delivered an address of welcome, laying stress upon the important part the association and its members can play in the winning of the war, especially through the preservation of the health and efficiency of the fighting forces and civilian populations of the United States and Canada. An informal reception and dance was then held by courtesy of the local entertainment committee.

The convention started business Tuesday morning with an illustrated address by Geo. W. Fuller, of New York City, on "Emergency Construction Work Due to War Conditions." The speaker made special mention of the important post which is held by a past-president of the association, Lt.-Col. Dabney H. Maury, who is supervising the sanitary conditions at the United States army cantonments. Following this address, reports of various committees were read. Owing to the fact that the president, Major Theodore A. Liesen, is engaged in military work, the chair was occupied by the vice-president, Allan W. Cuddeback, engineer and superintendent of the Passaic Water Co., Paterson, N.J.

In the afternoon the delegates were invited to join either of two parties. Those who were golfers were provided with transportation to the Midland Valley Country Club, where a tournament was held under the auspices of the Permanent Golf Committee of the Waterworks Manufacturers' Association and the American Waterworks Association. Twenty-seven members entered the tournament. The other delegates and their guests were taken by special cars to the Anhauser-Busch brewing plant, which employs about 6,200 people, where the automatic machinery was inspected.

Technical Papers Were Read

Tuesday's evening session was devoted to the reading of the following papers (while the ladies were entertained at a card party through the courtesy of the Waterworks Manufacturers' Association):—

"Management of Public Utilities in Cantonments," by Major P. Junkersfeld; "The Artesian Water Supply of Savannah, Georgia," by E. R. Conant; "Design of a Tilting Dam and Its Relation to Back Water on the Gunpowder River," by V. B. Siems; "Water Treatment Conditions at Council Grove, Kansas," by Louis L. Tribus.

Four papers were read on Wednesday morning. These dealt with various phases of the waterworks here, and were particularly timely in view of the fact that a trip of inspection to the waterworks plant had been ar-

ranged for Wednesday afternoon. The titles of the papers were:—

"Some Phases of Distribution Work," by W. A. Foley; "Double Forty-Eight-Inch Manifold at Bissell's Point," by C. M. Daily; "New 110-Million Gallon Pump at Chain of Rocks," by L. A. Day; and "Some Aspects of the Chemical Treatment at St. Louis Waterworks," by A. V. Graf.

Seventy Members From Canada

After these papers had been presented, the nominating committee was elected; then the suggesed places for holding the 1919 convention were voted upon. The Dominion of Canada has now seventy members in the American Waterworks Association, so H. Hymmen, of Kitchener, Ont., was elected from District No. 1 as the district's representative on the nominating committee. This district includes the Dominion of Canada and the states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, Michigan and Wisconsin. Only two cities made a decided bid for the 1919 convention,—Buffalo and Detroit. Buffalo got 114 votes; Detroit, 52; so the next convention will be at Buffalo, N.Y.

At noon (Wednesday) the delegates sailed up the Mississippi River for about twenty miles, to the mouth of the Missouri River. On the return trip a stop was made at the city's waterworks, and the pumping and filter plants were inspected. The supply is pumped from the Mississippi River into seven settling basins that have a combined capacity of 200 million gallons. The mechanical filter plant, which was installed by the Pittsburg Filter Manufacturing Co., has a registered capacity of 160 million gallons per 24 hours, and is the largest filter plant in the world.

The pumping equipment consists of four Allis-Chalmers engines, with a capacity of 40 million gallons per day; twin De Laval steam turbine pumps, with a capacity of 30 million gallons per day; and a 110-million-gallon De Laval steam turbine pump which is now under construction.

Toronto Member Killed at the Front

Three papers were read Wednesday evening:—"The Literature of Field Water Supply," by Jack J. Hinman, Jr.; "The Practicability of Adopting Standards of Quality for Water Supplies," by Robert Morse and Abel Wolman (see page 485 of this issue); and "The Preliminary Analysis of the Degree and Nature of Bacterial Removal in Filter Plants," by Abel Wolman.

Thursday was "Superintendents' Day," and was devoted to general discussion on water mains, water consumption, frozen service pipes, fire hydrants, office records, pipe-laying, etc. In the evening two papers were read:—"Loss of Head in Service Cocks and Service Pipes," by B. J. Bleisteine; and "Lead Pipe Couplings," by J. A. Jensen.

Four amendmens to the constitution, which were sent out to the members some weeks ago, were adopted almost unanimously.

The service flag of the association, which hung outside the door of Secretary Diven, showed that 109 members are serving in the allied armies and navies. Only one member has been called upon to pay the supreme sacrifice, Lt.-Col. T. C. Irving, of Toronto, who was killed October 30th, 1917.

Officers were elected for the coming year as follows:—President, Charles R. Henderson, manager of the Davenport Water Co., Davenport, Iowa; vice-president; Carlton E. Davis, chief of the Bureau of Water, Philadelphia, Pa.; treasurer, James M. Caird, consulting chemist, Troy, N.Y.; trustees, J. J. Hinman, Jr., State Board of Health, Iowa, Ia.; and Allan W. Cuddeback, Passaic Water Co., Paterson, N.J.

At a meeting of the American Waterworks Manufacturers' Association, held during the convention, the following officers were elected for the ensuing year:—President, T. C. Clifford, of the Pittsburg Meter Co.; vice-president, E. D. Kingsley, of the Electro-Bleaching Gas Co.; secretary, John A. Kienle, of the Electro-Bleaching Gas Co.; treasurer, Chas. R. Wood, of R. D. Wood & Co.

Fifty Exhibits, All Uniform

Owing to transportation difficulties, it was deemed advisable to confine the exhibits chiefly to displays of models, photographs, drawings, etc. Each exhibitor was limited to 50 lbs. as the weight of his exhibit. There were about fifty booths, all uniform in size and arrangement. The general appearance of the exhibition was very attractive, as the booths were handsomely decorated. Among those who had booths were the following:—

Birch-Hintz Co., Chicago. Represented by W. T. Birch, of the Chicago office.

Buffalo Meter Co., Buffalo. Represented by E. W. Widdows, of the Chicago office.

Builders Iron Foundry, Providence, R.I. Represented by A. B. Coulters, of Providence, and D. J. Purdie, of New York.

Dixon Crucible Co., Joseph, Jersey City. Represented by A. T. L. Smith, of St. Louis.

Eddy Valve Co., Waterford, N.Y. Represented by Harry A. Holmes, of Waterford.

Electro-Bleaching Gas Co., New York City. Represented by E. D. Kingsley, president; John A. Kienle; G. R. Ellis; S. W. Jacobs; and D. K. Bartlett, who recently joined this firm after having been with the Builders Iron Co. for several years.

Harrison Bros., Inc., Philadelphia, Pa. Represented by J. J. Haas.

Leadite Co., Inc., Philadelphia, Pa. Represented by Geo. McKay, Jr., and James P. McKay.

Modern Iron Works, Quincy, Ill. Represented by Dwight P. Child, assistant manager.

Mueller Mfg. Co., Decatur, Ill., and Sarnia, Ont. Represented by Fred B. Mueller and E. E. Pedlow.

National Water Main Cleaning Co., New York. Represented by Burt Hodgman.

Neptune Meter Co., New York. Represented by S. T. Hard and H. A. Beynon.

New York Continental Filtration Co., New York. Represented by Arthur M. Crane, general sales manager.

Pennsylvania S. F. Mfg. Co., Philadelphia, Pa. Represented by N. E. Bartlett, of Philadelphia.

Permutit Co., New York. Represented by J. L. Cheney.

Pitometer Co., New York. Represented by E. S. Cole, president, and E. D. Case, manager.

Pittsburg Filter Mfg. Co., Pittsburg, Pa. Represented by J. P. Leopold and E. W. Bacharach.

Pittsburg Meter Co., Pittsburg, Pa. Represented by T. C. Clifford, F. H. Bradford, R. M. Stottler and S. G. Swaffield.

R. U. V. Co., New York City. Represented by Mason Hullet, of New York City, and Dr. Harry M. Hill, of the Kansas City office.

Renssellaer Valve Co., Troy, N.Y. Represented by Irving K. Rowe and Geo. A. Keefer, both of Troy.

Ross Valve Co., Troy, N.Y. Represented by Wm. Ross, of Troy. *(Concluded on next page)*

Smith Co., A. P., East Orange, N.J. Represented by A. T. Halpin, W. A. Start, A. C. Nilman and J. W. Strackbein.

Sullivan Machinery Co., Chicago, Ill. Represented by D. H. Hunter, of the St. Louis office. This firm showed drawings of their air lift pumps.

Wallace & Tiernan Co., New York. Represented by M. F. Tiernan, president; R. E. Murphy, of New York City; and C. A. Jennings, of Chicago.

Wood & Co., R. D., Philadelphia, Pa. Represented by Chas. R. Wood, J. Wistar and Vincent McCarthy

C.N.R. ARBITRATORS' REPORT

PLACING the value of the 600,000 shares of common stock of the Canadian Northern Railway at $10,-800,000, and determining that each party shall pay its own share of the costs of the arbitration, the award unanimously agreed upon by Sir William Meredith, Hon. R. E. Harris and Hon. Wallace Nesbitt has been officially announced. The maximum payment was limited to $10,000,000 by act of parliament, and while the arbitration board places the value at $800,000 more than that figure, probably only $10,000,000 will be paid, as the Mackenzie & Mann and Canadian Bank of Commerce interests are said to have agreed to accept that sum in case a larger valuation should be awarded by the arbitrators. The report is as follows:—

"We, the Honorable Sir William Ralph Meredith, chief justice of Ontario; the Honorable Robert Edward Harris, chief justice of the supreme court of Nova Scotia; and the Honorable Wallace Nesbitt, of the City of Toronto, the arbitrators appointed under the provisions of an agreement bearing date the first day of October, nineteen hundred and seventeen, between His Majesty the King, represented herein by the minister of finance and receiver-general, and the minister of railways and canals, acting under the authority of an order-in-council, dated the fifteenth day of November, nineteen hundred and seventeen, of the first part, and Mackenzie, Mann & Company, Limited, of the second part, and the Canadian Bank of Commerce of the third part, to determine the value of the six hundred thousand shares of the capital stock of the Canadian Northern Railway mentioned therein, as of the date of the agreement, having taken upon ourselves the burden of the reference and heard the parties by their counsel and the evidence adduced, do award and determine:—

Value Was $10,800,000

"1.—That the value of the said six hundred thousand shares as of the date of the agreement was the sum of ten million eight hundred thousand dollars.

"2.—That the parties shall respectively pay and bear their own costs of arbitration, except that the government of Canada shall pay the expenses of taking and transcribing the evidence, the remuneration of the secretary and messenger employed by us and the incidental expenses incurred by the secretary.

"The question to be determined by the arbitrators was one of great difficulty and one which, of necessity, admitted of great diversity of opinion. We heard much testimony and had the benefit of assistance of experienced and able counsel on both sides, and carefully investigated every matter which seemed to throw any light upon the question to be determined. As to whether or not there was a surplus of assets over liabilities was naturally a subject which engaged much time and consideration. It is, of course, not a conclusive test as to the value of the stock, but it is an element which cannot be ignored. Its importance was perhaps emphasized by the fact that a royal commission had reported the assets and liabilities of the company to be about equal. This report which was made in a proceeding to which the company and its shareholders were not parties, was admittedly based on a misconception of some of the facts, and there were omissions of both assets and liabilities. It should also be pointed out that the work of the royal commission had reference to a date anterior to the first day of October, 1917, and there were changes in the interval.

"In arriving at the surplus of assets over liabilities, the report of Prof. Swain as to the reproduction cost new of the physical property based on pre-war prices, and also his estimate of the depreciation, has been adopted, and after a careful examination we found the surplus of assets over liabilities of the company on the first day of October, 1917, on a conservative basis, to be not less than twenty-five million dollars, after deducting the full amount of depreciation found by Prof. Swain, and making such reduction in the value of the land grants and other assets as deemed reasonable.

Reproduction Less Depreciation Not Accurate

"It is to be pointed out that a valuation of the physical property of a railway company by the reproduction new method, less depreciation, is not to be regarded as an ascertainment of the actual value. It is only a means to that end, but as it was the best, and in fact the only estimate available, it has been adopted as a basis for the foregoing calculations.

"While the surplus of assets over liabilities is an element for consideration, as has been already pointed out, it is not conclusive as to the value of the stock of the company. Its prospective earning power is perhaps more important than any other element in ascertaining such value, and in arriving at a conclusion we have given careful consideration to the past history of the company, its earnings and expenditures, the present financial position of the company, the location of its lines and their construction, the other railways already existing in competition, the rate of interest on the funded and other debts of the company, the probable future growth of the population and business of the country, and all other factors which seemed to us to have any bearing upon the question.

"It is apparent that there was great room for difference of opinion in a matter involving so many elements of uncertainty and speculation, but after taking into consideration all the circumstances which appeared to us to be entitled to weight in determining so difficult a question, we came to the conclusion we have mentioned.

"In witness whereof we have hereunto set our hands this twenty-fifth day of May, 1918.

"Signed, published and declared (in triplicate) in presence of E. Oliver. W. R. Meredith; Robt. E. Harris; Wallace Nesbitt.

Manitoba spent $466,946 during 1917 under the Provincial Good Roads Act. Of this amount the province contributed $220,996 in cash to the municipalities, besides the services of the provincial highway engineering department. A total of 264.81 of roads were constructed during the year, of which 174.07 were earth roads and 90.74 were gravel. Up to the beginning of this year there had been constructed altogether, under the act, 580.76 miles of roads, of which 365.82 were earth roads, 191.69 were gravel and 23.25 were asphalt or concrete.

ENGLISH AND AMERICAN PRACTICE IN THE CONSTRUCTION OF TAR SURFACES AND PAVEMENTS*

By Arthur H. Blanchard, M.Can.Soc.C.E.
Consulting Highway Engineer, New York City

TAR was used as a material for the construction of pavements as early as 1820, when a tar macadam pavement was laid in London. In 1834 an English patent was issued covering some of the features of the modern Pitchmac pavement. Tar concrete pavements were first built probably about 1840, in Nottingham, England. In Canada, tar concrete pavements were constructed in Ontario in the period from 1880 to 1891. Highway engineers in the United States have used tar concrete pavements in municipalities since 1870. It was not until 1906, however, that tar concrete was given consideration as a pavement for use on State highways. After conducting service tests for three years, Rhode Island, in 1909, was the first state to adopt the tar concrete pavement as a standard type for use on highways outside urban districts. Tar was first used for surface treatments in France in 1871. In the United States, thin tar surfaces were first employed in 1894, in Montclair, N.J. In America, however, the rapid development of the use of tar for surface treatment did not begin until 1906.

Tar Surfaces

Classification—Tar surfaces may be considered as divided into two classes.

The first class consists of thin superficial coats of tar with or without the addition of such materials as stone chips, fine gravel or sand. When this type of tar surface has been under traffic for from one to two years, the road metal, or other material composing the wearing course, is exposed.

The second class consists of coats of tarred material of appreciable thickness, usually over ½-inch, and are formed by the application of one or more treatments of tar with sand, gravel or stone chips added. Surfaces of this class are known as tar carpets or blankets. They rarely wear down uniformly to the wearing course and hence increase unevenly in thickness by retreatments.

English Hand Spraying Machine

Construction—Before constructing a tar surface on a broken stone or gravel road, every precaution should be taken to secure the best subdrainage which is practicable under the local conditions. All depressions, pot-holes, ruts or other irregularities should be filled with thoroughly compacted, tar-coated stone so that the whole surface of the roadway is even. All surplus dust must be removed so that the larger pieces of broken stone of the roadway surface are exposed, but without breaking the bond. This cleaning process is accomplished by the use of horse sweepers and fine bass brooms, with coarse fibre brooms and fine bass brooms, or by a vacuum process. If there is caked mud on the surface of the roadway, wet brushing will prove advantageous.

French Gravity Distributor Equipped with Brushes

It is apparent that the character of the cleaned surface will be affected by the method which was used in the original construction of the roadway. If there be followed the practice of some English and American engineers in using large-size stone varying from 1 to 2½ inches in longest dimensions for the top course of a broken stone road, and if the stone be hard and tough, the desired surface can be easily secured. The surface of the large stones in such a roadway are easily cleaned by brushing, without the dislodgment of stones in the surface. A clean mosaic surface is of the utmost importance from the standpoint of the formation of a satisfactory bond between the broken stone and the tar. The maintenance of tar surfaces on wearing courses of large broken stone is economical, since after the tar surface wears away in spots, the mechanically interlocked large stones will of themselves generally have sufficient stability to withstand the effects of traffic until retreated.

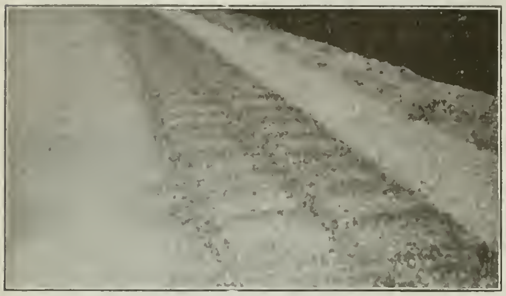
On the other hand, if the top course of a broken-stone road has been constructed of a product varying in size from ¼ to 1¼ inches, it will be very difficult, if not impossible in the case of soft stone, to secure an even, clean surface. Even after thorough brushing, a film of impalpable dust usually covers the surface of the roadway. During hard brushing small depressions will probably be formed by the displacement of pockets of dust and the smaller sizes of stone. Furthermore, the wheels of vehicles may adhere to the tar and thus tear up the small mineral matter adhering to it. As soon as the tar surface wears out in spots, rapid disintegration of the exposed broken stone or gravel surface, with the consequent formation of pot-holes, is apt to occur.

If a tar surface is to be constructed on a new broken-stone or gravel road, or on one which has just been resurfaced, the tar should not be applied until the crust has had time to consolidate under the action of traffic and with the aid of the binding action of dust and moisture. If it be impracticable to postpone the surface treatment, special care should be taken to secure a maximum consolidation of the crust of the roadway by puddling and rolling.

*Address delivered May 8th, 1918, at Canadian Good Roads Congress.

When the tar is applied, the roadway surface should be bone dry. If the surface is damp, it will be difficult to secure a good bond. Distribution of the tar is accomplished by two methods, (1) flow by gravity, (2) mechanical pressure.

The use of gravity distributors has not been developed

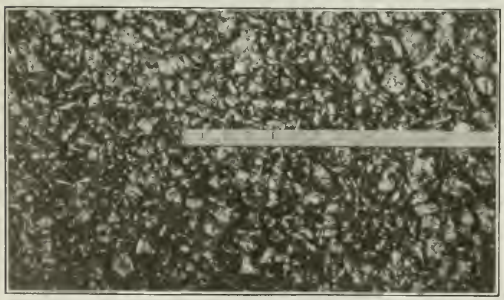


Uneven Distribution of the Binder

to its fullest extent in America, in that the use of mechanical brushes, or the brushing of the material into the road by hand brooming, has never been adopted extensively. By brushing after gravity distribution, it is possible to distribute uniformly ¼ to 1.5 gallons of tar per square yard. In some cases, when the distribution is accomplished by hand brooming, the adhesion of the material to the road metal is as good as when the material is applied under pressure. The advantages claimed for pressure distributors are the following:—

Aid in cleaning the surface of the roadway; even application; distribution of small amounts per square yard; satisfactory adhesion obtained between the tar and the surface of a clean, dry roadway; and rapid, economical distribution.

As a general rule, from ¼ to ½ gallon per square yard is used for the first treatment, preferably in two applications. The amount applied per treatment depends upon the kind of tar, the character and condition of the surface, and the details of the method of application. For example, a smooth surface composed of large-sized, tough,



Surface of Tar Concrete, Class A, Before Application of Seal Coat

hard stone, well compacted by traffic, would require from 0.25 to 0.35 gallon; for a somewhat rough surface of stone having a medium toughness and hardness and recently resurfaced, it would be necessary to use from 0.35 to 0.5 gallon per square yard to form a satisfactory thin tar surface.

The superficial coat of tar is usually covered with either coarse sand, fine gravel or stone chips varying from ⅛ to ½ inch in longest dimension. Material containing clay should not be used, as disintegration may result by the emulsifying of the clay and water on the tar surface. The amount of sand, stone chips or gravel used per square yard depends upon the quantity and kind of the tar and the character of the surface of the roadway. From 5 to 20 pounds per square yard have been used satisfactorily for thin tar surfaces; 5 to 12 pounds for from 0.1 to 0.25 gallon of tar per square yard; 10 to 17 pounds for 0.25 to 0.35 gallon; and 15 to 20 pounds for from 0.35 to 0.5 gallon.

Cost Data—Under normal conditions, with labor and foreman at $2 and $4 respectively for an 8-hour day; teams, $5 per day; refined tar, applied, 7 to 9 cents per gallon; and top covering, $2 to $2.25 per ton, delivered; the cost of tar surfaces, using from 0.25 to 0.4 gallon of tar per square yard, will vary from four to eight cents.

Tar Macadam Pavements

Definition—A tar macadam pavement is one having a wearing course of macadam with the interstices filled by a penetration method with a tar cement.

Pitchmac on Princes Avenue, Liverpool

Foundations—Usually tar macadam pavements are constructed on broken-stone or gravel foundations. In cases where traffic conditions require rigid foundations, or where materials satisfactory for cement-concrete may be secured at a much lower cost than broken stone, cement-concrete foundations have been used and have been found to be satisfactory and economical. The more general use of cement-concrete foundations is advisable on trunk or other highways where traffic is likely to increase rapidly both in amount and weight. When it is necessary to construct a more durable type of wearing course than tar macadam, the cement-concrete foundation previously constructed proves a valuable asset and allows reconstruction to be accomplished economically.

Physical Properties of Road Metal—The weight to be given to toughness and resistance to abrasion depends primarily upon the traffic to which the pavement will be subjected and the details of the method of construction adopted. For example, for many highways serving as feeders to State trunk routes, a rock having a toughness of not less than six and an abrasion loss of not more than 6% would prove economical and satisfactory; but if used on State trunk highways subjected to horse-drawn or motor-trucks, rock having a toughness of not less than thirteen and an abrasion loss of not more than 3.5% should be employed. In cases where rock with suitable toughness and wearing quality is not locally available,

satisfactory results may be obtained by importing the broken stone for the surface of the pavement and using local rock for the lower part of the crust.

In order that road metal should interlock during compaction and thus provide a stable wearing course, a proper angularity is an important prerequisite. The road metal should not contain over 5% of particles having small acute angles, nor should the product contain slivers. Road metal which has a rough or coarse grain or pitted surface is preferable to material with smooth or glassy surfaces, as the tar cement adheres more satisfactorily to the former than to the latter. Cleanliness is an essential quality of road metal for the wearing course of tar macadam pavements. It is difficult and usually impossible to secure a good adhesion of the tar cement to road metal which is not clean.

Construction—In the construction of tar macadam pavements it is desired to secure (1) a stable wearing course consisting of broken stone or similar material thoroughly rolled so that it will be well compacted and keyed together, and with the several sizes of material uniformly distributed; and (2) a uniform distribution and penetration of the tar within the upper 1½ to 3 inches of the crust.

Construction of Pitchmac Pavement, Liverpool

Several methods of construction have been devised with a view to meeting the above prerequisites. Careful supervision, based on experience, is necessary to prevent non-uniformity in the density of the wearing course of broken stone and in the amount of tar applied per square yard. It is evident that uniform application of the tar will depend upon the method of distribution employed. In using vehicular distributors, one cause of uneven distribution of the tar is overlapping of applications. The use of strips of tar paper or wrapping paper, from 3 to 5 feet in width, placed at the edge of an application, has prevented sections of the wearing course receiving double the amount of tar cement specified.

A typical American method of construction is as follows: The metalling of the wearing course is a uniform product of about 1 or 1½ inches in size or a product similar to or larger than one passing over a 1½-inch and through a 2½-inch screen, and the voids in the upper part of the wearing course are filled after the tar cement is applied. Practice varies with reference to the amount of rolling of the wearing course prior to the application of the tar cement. For traffic medium or heavy in weight and amount, the best results have been secured by thoroughly rolling the road metal and thus securing maximum interlocking of the particles and thereby securing the highest degree of stability practicable by this method. The tar cement is applied in an amount varying from 1½ to 2 gallons per square yard, after which ⅜-inch stone chips, or a product similar to one passing a ½ inch and through a 1-inch screen, is spread and thoroughly rolled. Usually the surface is then broomed with stiff brooms, removing the excess loose broken stone, and another coat of tar cement, from ⅓ to 1 gallon per square yard, is applied, covered with a layer of stone chips or pea gravel, and rolled.

Wrong Way to Use Pouring Cans

A tar macadam pavement called "Pitchmac" by its inventor, J. A. Brodie, city engineer of Liverpool, England, has been used to a considerable extent in that country and has been adopted as a standard type by the English road board. It is constructed on a foundation of stone. The wearing course of broken stone varies from 2 to 4½ inches in depth, dependent upon traffic conditions. If the wearing course is from 2 to 3 inches in thickness, it is constructed in one layer; and if from 4 to 4½ inches, in two layers. The single layer (or, in the case of two layers, the upper layer) is composed of broken stone ranging in size from 1¼ to 2½ inches. After thorough rolling, the tar compound is applied to the single layer or to each of the layers of the two-layer wearing course. The tar compound used in England consists of hot sand mixed with tar pitch. From 1¼ to 2 gallons per square yard are used for the one-layer wearing course, and from 3¼ to 3½ gallons for the two layers.

Right Way to Use Pouring Cans

To assist in completely filling the voids, chips varying in size from ⅜ to ¾ inches are applied during the rolling of the tar-grouted layer.

The oldest sample of Pitchmac in Liverpool was laid in Princes Avenue, in 1901, near the end of Eversley Street, and has been in continuous use ever since without repair. This avenue carries a large volume of light motor

and carriage traffic, as well as some of a heavier character, the traffic amounting to 120,000 tons per yard width per annum.

Pitchmac has been used to a limited extent in Massachusetts. The writer is indebted to Arthur W. Dean, chief engineer of the Massachusetts Highway Commission, for the following authoritative and instructive data covering the cost of construction and maintenance of Pitchmac pavements in Massachusetts having top courses of two inches, filled with tar and sand, and foundation courses of 4 inches of broken stone:—

Roads	Year Built	Cost	Maintenance Per Sq. Yd.	Traffic
Tyngsboro W. .	1913	$1.01	$0.0118	Medium
Natick E.	1914	1.12	0.0191	Heavy
Newton	1914	1.21	0.0118	Medium
Reading S.	1914	1.18	0.0266	Very heavy
Wayland	1914	1.46	0.0175	Very heavy
Gloucester W. .	1915	1.15	0.0141	Medium
Boston	1916	1.20	0.0000	Heavy

Notes:—The condition of all these roads is good. The character of traffic on the several sections is as follows:—

Tyngsboro W.—Heavy pleasure travel, truck and logging teams in spring and fall.

Natick E.—Pleasure cars, trucks between Framingham and Boston.

Newton—Pleasure cars 70%, trucks 15%, teaming 15%.

Reading S.—Pleasure cars, very heavy trucking.

Wayland—Pleasure cars, very heavy trucking.

Gloucester W.—Pleasure cars 80%, trucks 10%, teams 10%.

Boston—Mostly trucks and teaming, pleasure cars 30%.

The maintenance cost quoted is the average per square yard per year since the surface was laid, and with the exception of the Reading S. road, is entirely for sanding. There having been no repairs made nor necessary, nor probably will be for some years. At Reading the contractor had poor workmen and early corrections were necessary on that account. The sanding was necessary mostly on account of surplus tar on surface, and perhaps 25% for slipperiness during cold weather. Notice no repair expense at Boston, due to perfect workmanship. This was partly the result of experience, as it was the latest piece laid and can be equalled under favorable conditions.

Distributors—The appliances used in the distribution of tar cements may be classified as gravity distributors and pressure distributors. The market is supplied with so many different types, that a thorough investigation should be made preceding the purchase of a machine. The following factors should be given consideration when selecting a distributor:—

(1) Character and range of work upon which the distributor will be used.

(2) Present and probable requirements in specifications pertaining to type and details of distributors and the work to be done.

(3) Different types and grades of tar cements which the machine will distribute, and the range in the amount per square yard which can be applied.

(4) Gravity or pressure distribution, and, if the latter, the range in pressure per square inch.

(5) Method of controlling uniformity and amount of distribution.

(6) Accessories of distributors for heating material, recording temperature of tar cement, amount in tank and amount of pressure, and for shutting off tar cement at end of run.

(7) Width of distribution and means for modifying same.

(8) Motive power.

(9) Width of tires and loads per linear inch of tires when tank is full.

(10) Ease of operation and repair.

(11) Structural strength.

(12) Amount and character of labor required to efficiently operate the distributor.

(13) Economics, including overhead operation and maintenance charges.

Cost Data—The cost of tar pavements built by penetration methods varies with the amount and kind of tar cement and road metal used and the method of construction employed. An average cost, using 6 to 8 inches of compacted broken stone and a total of 2 to 2¾ gallons of tar cement per square yard, varies from 25 to 40 cents per square yard in excess of the cost of waterbound broken stone roads, or from 70 cents to $1.25 per square yard.

Tar Concrete Pavements

Definition—A tar concrete is one composed of broken stone, broken slag, gravel or shell, with or without sand, portland cement, fine inert material or combinations thereof, and a tar cement incorporated together by a mixing method.

Classification—Tar concrete pavements may generally be grouped into three classes. The essential characteristics of these classes are as follows:—

Class A—A tar concrete pavement having a mineral aggregate composed of one product of a crushing or screening plant.

Class B—A tar concrete pavement having a mineral aggregate composed of a certain number of parts by weight or volume of one product of a crushing or screening plant, and a certain number of parts by weight or volume of sand, broken stone screenings or similar material, with or without a filler.

Class C—A tar concrete pavement having a predetermined, mechanically graded aggregate composed of broken stone, broken slag, gravel or shell, with or without sand, portland cement, fine inert material or combinations thereof.

Patent Litigation—In connection with the design or selection of a suitable type of tar concrete pavement, it is necessary to consider the possibility of an infringement suit being brought by one of the patentees of proprietary pavements. Highway engineers and contractors are primarily interested in the types of tar concrete pavements which may be constructed without danger of litigation rather than in a voluminous discussion of the probabilities of successfully defending infringement suits.

Class A—There is ample evidence at hand that tar concrete pavements of this class may be constructed without danger of litigation proceedings.

Class B—The history of litigation cases indicates that the construction of unpatented tar concrete pavements of this class on a large scale will in all probability lead to an infringement suit.

Class C—With the exception of the class of tar concrete pavements having mineral aggregates similar to that covered by the Topeka decree, the extensive use of non-patented tar concrete pavements of this class will usually lead to litigation proceedings.

Foundations—Many failures have occurred due to laying tar concrete pavements on weak foundations. Of the more common types of foundations, satisfactory results have been obtained under medium traffic with thoroughly filled and compacted broken stone and tar-concrete foundations. Cement-concrete foundations should generally be used.

Construction—Under Class A, two types of pavements will be considered. The most efficient type, as laid in America, has a mineral aggregate which will comply with the following requirements:—

All of the broken stone or broken slag shall pass a 1¼-inch screen; not more than 10% nor less than 1% shall be retained on a 1-inch screen; not more than 10% nor less than 3% shall pass a ¼-inch screen.

This aggregate, for small jobs, may be mixed with hot tar cement by hand methods. Usually, however, mechanical heating and mixing plants should be used. In a complete plant for the manufacture of tar concrete, the aggregate is carried by bucket elevators to rotary dryers, where it is dried and the dust exhausted. From the dryer the aggregate is raised by elevators to storage bins. When required the aggregate is drawn from the bins to a weighing device, and from there deposited into a mixer. Such plants are also equipped with tar cement heating tanks and weighing buckets. A plant of this type should have a capacity of from 800 to 1,000 square yards of 2-inch wearing surface per day. For the type of tar concrete under consideration, it has been found that the tar mixture should contain between 5% and 8% of bitumen.

An important detail of laying is thorough rolling. An even surface and adequate compaction, with thorough interlocking of the particles of broken stone, may be readily obtained by the proper use of a tandem roller weighing between 10 and 12 tons.

Many methods have been developed for the application of the seal coat of tar. It has been found that seal coats of from ½ to 1 gallon of tar cement per square yard are distributed most uniformly by the use of hand-drawn gravity distributors, followed by a squeegee.

The average cost of this type of tar concrete under normal conditions, when laid as a 2-inch wearing course, should be from 25 to 40 cents in excess of a waterbound broken-stone wearing course of the same thickness.

The second type of tar concrete of Class A is the two or three-course pavement in which each course consists of one product of a crushing or screening plant. The excellent tar slag concrete pavements which have been laid in England since 1903 are of this type. Although used by various municipalities, the largest yardage of this type has been constructed by Tarmac, Limited. One of the Tarmac plants is located at Wolverhampton, adjacent to that of a company producing large quantities of blast-furnace slag. The large molds of slag are transported by small cars from the iron works on a narrow-gauge track and dumped near the Tarmac works. These large blocks, while still warm, are broken by sledge-hammers to a size suitable for the crusher. After it is crushed and screened into sizes varying from ¼ to 2½ inches, it is mixed with a tar compound. Since the slag is warm even after it has been crushed, no heating preliminary to mixing is necessary.

Although in some cases two courses of tar slag concrete are used, usually more than two layers of tar-coated slag are employed, as was the case with tar slag concrete pavement laid at Brighton-on-Sea. The details of construction follow:—

On a well-compacted gravel foundation was spread a scattering of tar-coated slag chips. The bottom layer was composed of 2½ inches of compacted 1¼ to 2½-inch tar-coated slag. The second course consisted of 2 inches of compacted ½ to 1½-inch tar-coated slag. The third course was composed of a thin layer of ⅛ to ⅜-inch tar-coated slag chips, which layer was thoroughly rolled. The pavement was finished by rolling a top dressing of uncoated fine slag screenings.

Tar concrete pavements of Class C, with mineral aggregates similar to the modern Topeka grading, were laid in Pittsburgh, Pa., about 1890. The pavement laid on Lang Avenue has been in service, with only nominal repairs, for the past twenty-six years. Many similar pavements were constructed in several cities of New England as early as 1885. Since 1913, tar Topeka pavements have been laid in several States throughout the middle west of the United States and also in cities of New England. Some of the best examples of this type of tar concrete pavement have been constructed with about 8% of tar bitumen in the mix, and with a light seal coat of refined tar.

PRACTICABILITY OF ADOPTING STANDARDS OF QUALITY FOR WATER SUPPLIES*

By Robert B. Morse† and Abel Wolman‡
Maryland State Department of Health

In spite of the fact that the attempt to establish a so-called standard to serve as a basis for interpreting or classifying the quality of potable waters has met with but little success in the past, endeavors are still being made to standardize the consideration of analytical results so as to eliminate personal judgment as a feature of interpretation. The difficulties besetting these efforts, such as the undetermined significance of the bacterial test made by various methods, the importance of varying chemical content and the evidence of sanitary surroundings, are still present in probably a greater degree than in the past, on account of the development of the science of water bio-chemistry and the added confusion created by the ever-changing methods, media, temperature, and differentiations.

Before establishing a measure of the quality of a potable water, it is necessary to determine by what units such measurements are to be evaluated. In the case of water supplies, the choice of appropriate units becomes difficult, since the question immediately arises as to whether the bacterial count, the B. coli test, the chemical determinations, or the sanitary inspection, should be the sole criterion; or if a combination of these factors, as to what their relative importance should be in any proposed unit of measure. Manifestly, a standard in its simplest terms could be predicated upon any single one of the above-mentioned units, if we assume that such a standard would fulfil the requirements of a universal measure of quality. Even then the problem still remains of deciding what unit of bacterial content, for instance, shall be chosen as the basis for comparison.

A unit of measure must be found upon the existence of an absolute uniformity of condition and of material which can be made to serve as the immutable basis for future comparative readings. The unit of length, for example, is that distance between the ends of a bar of definite material, in a definite place, measured and corrected for predetermined conditions of atmospheric pressure and temperature. Such a unit immediately establishes a precise standard by means of which further measurements of length under all conditions may be carried out. The search for a "quality standard" for water should be first directed, therefore, towards determining whether there

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*Abstracted from paper read at convention of the American Water Works Association, St. Louis, May 15th, 1918.

†Chief Engineer.

‡Division Engineer.

are available any definite units in sanitary science which could serve as the basis for a standard.

If the water analysts have agreed upon well-defined methods of water analysis, then the evaluation of a standard would be at least possible, if not valuable, for interpretation. In order to learn whether any degree of uniformity existed in the laboratory examination of water supplies, a questionnaire was submitted to thirty-three state department of health laboratories in the United States. Thirty-two answers were received and sufficiently detailed information was obtained to warrant the conclusions later to be discussed. With these data at hand, the practicability, at the present time, of formulating a standard of quality for water, in the light of present-day analytical practice, may be discussed with more precision.

Total Bacterial Count

The total number of bacteria in a stated quantity of water has been used frequently in establishing a maximum allowable pollution in potable waters. One of the more recent of these is the requirement of the United States Treasury Department that water supplied to common carriers should contain no more than 100 bacteria per c.c. (37° 24 hours agar). The creation of such standards presupposes a unanimity of opinion as to the significance and importance of particular bacterial counts obtained by definite procedures, over others found by any other methods. Such an agreement would be reflected, of course, in the routine procedures of such laboratories of which we have record. The data in Table I. disclose, however, a disconcertingly wide difference, rather than agreement, of attitude toward the various methods. If official water analysts differ in their choice of the method of making total counts, it is reasonable to conclude that their disagreement would be even greater in a choice of a "standard" total count. Since the relative significance, for instance, of the total number of bacteria on a plain agar plate at 37° C., as compared with the count on a gelatine plate at 20° C., is still a moot question, it is clear that more confusion in interpretation will result when several additional different combinations of media, temperatures, and periods of incubation are to be considered.

It is also of striking interest to note that, in spite of the fact that the 37° C. agar count at 24 hours incubation has been for several years an official standard procedure of at least two organizations (American Public Health Association and U.S. Treasury Department), only 19, or

Table I.—Method of Obtaining Total Bacterial Count in Laboratories of Various State Departments of Health

Name of State	20° C. Gelatine		20° C. Agar		37° C. Gelatine	37° C. Agar		Lit. Lact. Agar	
Hours:—	48	96	48	96	48	24	48	24	48
Alabama	No definite information								
California	.	.	.	.	.	x	.	.	.
Connecticut	x	.	.	.	.	x	.	.	.
Dist. of Columbia	.	.	x(a)	.	.	.	.	.	.
Florida	.	.	.	.	.	.	x	.	.
Georgia	.	.	.	.	.	x	.	.	.
Illinois	x	.	.	.	.	x	.	.	.
Indiana	.	.	.	.	.	x	.	.	.
Iowa	.	.	x	.	.	.	.	x	.
Kansas	x	.	.	.	.	x	.	.	.
Kentucky	.	.	.	.	.	x	.	.	.
Maine	x	.	.	.	.	x	.	.	.
Maryland	.	.	x	.	.	x	.	.	.
Massachusetts ..	.	.	.	x	.	.	.	x	.
Michigan	.	.	.	.	.	x	.	.	.
Minnesota	.	.	.	x	.	.	.	.	.
Missouri	.	.	.	.	.	x	x	.	.
Montana	.	.	.	.	.	x	.	.	.
New Hampshire	No definite information								
New Jersey	.	.	x	.	.	x	.	x	.
New York	.	.	.	.	x	x(b)	.	.	.
North Carolina..	x	.	.	.	.	.	.	x	.
Ohio	.	.	x	.	.	x	.	.	.
Oklahoma	.	.	.	.	.	x	.	.	.
Pennsylvania ...	.	.	.	.	.	.	x	.	.
Rhode Island ...	.	.	x	.	.	.	.	x	.
South Carolina..	.	.	.	.	.	x	x	.	.
South Dakota...	.	.	.	.	.	.	x	.	.
Vermont	.	.	.	.	.	x	.	.	.
Virginia	.	.	.	.	.	x	.	.	.
West Virginia ..	.	.	.	.	.	.	x	.	.
Wisconsin	.	x(c)	.	.	.	.	.	.	x
Wyoming	x	.	.	.	.	.	x	.	.

(a)—25° C. (b)—Infrequent. (c)—15° to 20° C.

NOTE.—Data in above table obtained by letter in 1917 from officials of various state departments of health.

Table II.—Method of Making Presumptive Tests for B. Coli in Laboratories of Various State Departments of Health

Name of State	Medium Used: Lact. Broth	Medium Used: Lact. Bile	Period of Incubation: 48 hrs.	Period of Incubation: 72 hrs.
Alabama	No definite information			
California	x	.	x	.
Connecticut	x	.	x	.
Dist. of Columbia	.	x	x	.
Florida	x	.	x	.
Georgia	x	.	x	.
Illinois	x	.	x	.
Indiana	x	.	x	.
Iowa	x	.	x	.
Kansas	x	x	x	.
Kentucky	x	.	x	.
Maine	.	x	x	.
Maryland	x	.	x	.
Massachusetts ...	x	.	x	.
Michigan	x	.	x	.
Minnesota	x	.	x	.
Missouri	x	.	x	.
Montana	x	.	x	.
New Hampshire..	.	x	x(36 hrs.)	
New Jersey	x	x(a)	x	.
New York	No presumptive test			
North Carolina ..	.	x	x	.
North Dakota ...	.	.	.	.
Ohio	x	.	x	.
Oklahoma	x	.	x	.
Pennsylvania ...	No presumptive test			
Rhode Island	x	.	x	.
South Carolina ..	.	x	.	x
South Dakota ...	x	.	x	.
Tennessee	.	.	.	.
Vermont	Lactose neutral red		x	.
Virginia	.	x	x	.
West Virginia ...	x	.	x	.
Wisconsin	No presumptive test			
Wyoming	No definite information			

(a)—Infrequent.

NOTE.—Data in above table obtained by letter in 1917 from officials of various state departments of health.

Table III.—The Effect of an Increased Period of Incubation in the Presumptive Test Upon the Possible Number of Confirmatory Tests

Total Number of Tubes Incubated and Giving Gas = 495

Gas Formation at End of	Number Tubes Showing Gas Total	Additional	Per Cent. Tubes Showing Gas Total	Additional	Number Confirmed Total	Additional	Per Cent. of Total Tubes Confirmed	Per Cent of Total Samples Confirmed
24 hours	18	18	3.6	3.6	17	17	6.2	3.4
48 hours	263	245	53.1	49.5	197	180	66.0	36.0
72 hours	448	185	90.5	37.4	264	67	24.6	13.4
96 hours	495	47	100.0	9.5	273	9	3.3	1.8

Note—Data obtained from routine analytical determinations in laboratory of Maryland State Department of Health during 1917. Presumptive tests in lactose broth. Confirmatory tests consisted of Endo, secondary lactose broth, and agar slant.

approximately 60 per cent., of the laboratories in question have seen fit to use this exact procedure as a routine measure. The percentage is undoubtedly higher than that which would represent the individual opinions of the analysts in these laboratories, in view of the fact that some of them have adopted the aforementioned methods on account of their official stamp rather than as a result of the conviction that they are superior to others. This conclusion is borne out by the fact that it has been by no means firmly established that the bacterial count, obtained as outlined by the Federal requirements, serves as the best index to the quality of a drinking water. In the light of the data illustrating the wide discrepancy in the method of obtaining the bacterial count, it would appear that effort should be directed towards further study of individual types of bacteria and their relative significance rather than towards an attempt to predicate a standard upon such an elusive and variable factor as the general bacterial count.

B. Coli

An index to sewage pollution in potable waters is an excellent asset in determining the safety of a supply if it "indicates." Some years ago, perhaps, the presence of B. coli in small quantities of water was considered sufficient evidence upon which to condemn the supply. He certainly would be venturesome who would issue a manifesto to-day as to the allowable frequency of B. coli in a safe water. He would indeed be skilled who can gather sufficiently consistent data out of the present chaotic conception of the significance of B. coli, and of how to obtain it, to be able to establish even a fairly elastic measure of quality.

Table II. illustrates, for instance, that the use of a medium for testing even the elementary phenomenon of gas formation is still open to question, while the significance of gas formation itself is disputed by authorities. Considerable evidence had supported previously the use of lactose bile, but the wind has apparently shifted in recent years and the balance now rests upon the importance of lactose broth as a better medium for an initial B. coli test. Each day brings forth another experimental factor to make the confusion greater as to the significance of lactose fracture.

The data given in Table II. show a close agreement in the laboratories as to the necessary period of incubation in the B. coli presumptive test. In the face of the almost universal choice of a 48-hour period, it is found in the Maryland State Department of Health laboratory that about 25 per cent. of all typical B. coli isolations are obtained from those tubes which show gas only after 72 hours incubation. It is somewhat doubtful, with the evidence shown in Table III., whether even the apparently settled question of period of incubation is not still debatable.

Uncertainty of Fermentation

In 1907, Phelps discussed a method of estimating the numbers of B. coli from fermentation tube results. His system of numerical interpretation has served, until recently, as a basis of practically all quantitative estimates of B. coli in various waters. A misconception of the method proposed at that time has been responsible in a degree for the eternal cry for standardization. The realization of the fact that "the method is obviously of no value for single tests and finds its most useful application in routine studies in water purification and sewage treatment extending over long periods of time" would tend to emphasize the utility, but uncertainty, of fermentation. Granting the value of establishing a maximum allowable pollution of "x" B. coli per 100 c.c., we are confronted still with the difficulty of estimating such numbers from data afforded by our present bacteriological methods.

Frequent Sampling Necessary

Past standards for B. coli content have shown a surprisingly patent disregard of the importance of stipulating the necessary frequency of sampling of a source before its quality may be safely postulated. In fact no standard comes to mind at the present time in which the number of samples is apparently considered of sufficient importance to warrant even a cursory establishment of a necessary minimum. In certifying a public water supply to com-

Table IV.—Number of Samples Necessary to Establish a B. Coli Content to Within the Probable Errors of 5 and 10 Per Cent.

(From Stein, "Engineering News-Record," May 24, 1917.)

Per Cent of Positive Tests in a Series	No. of Samples to Establish Coli per c.c. to Probable Error of ± 10 per cent.	± 5 per cent.
5	1,900	7,600
10	900	3,600
15	760	3,040
20	627	2,508
25	485	1,940
30	365	1,460
35	320	1,280
40	282	968
45	235	940
50	204	816
55	190	760
60	171	684
65	165	660
70	162	648
75	155	620
80	156	624
85	160	640
90	178	712
95	210	840

mon carriers, how many state departments of health insist upon a large series of samples before passing judgment upon the analytical findings? Some of these we know collect samples two or three or four times a year and then certify or do not certify on the bacterial content of some 500 c.c. of water out of a total consumption of millions of gallons per year. It is useless to justify such procedure upon the score that neither time nor finance are available to health officials to follow adequately, by frequent sampling, the condition of the supply. Infrequency of sampling, with consequent inaccuracy of interpretation, is not always recognized by sanitarians as dangerous. It is for this blindness to the invalidity of findings based on essentially variable phenomena and methods, that "standards" are in a measure directly responsible.

Stein has pointed out within the last year the extreme importance of an adequate number of tests before any relatively precise conclusions may be projected. Table IV. contains a portion of the data developed by Stein to show the number of samples necessary to establish varying B. coli contents to within a 5 or 10 per cent. probable error. In the Treasury Department standard an allowable maximum pollution equivalent to 20 per cent. of all tests positive in 10 c.c. is fixed. Twenty per cent. was chosen, we infer, in the belief that such a series of results would be comparable with a density of 2 B. coli per 100 c.c. in the water. It is highly disconcerting to learn that, in order to obtain even a fair degree of precision and an approximate approach to the above number of B. coli, something like 600 samples are necessary. How meagre, then, is the analytical information afforded by even ten samples a year and how ludicrous is the certification of a doubtful supply upon the basis of only two examinations a year! . . . The method of making the B. coli examination of a single sample of water is capable of wide manipulation. The procedure in some laboratories usually consists in the inoculation of a series of fermentation tubes of different dilutions. The dilutions as a rule are in the usual geometric progression of 10, 1, 0.1, etc., cubic centimeters. There does not appear, however, to be any well-defined agreement among authorities as to the necessary number of fermentation tubes to be used at each dilution.

Chemical Determinations

The importance of chemical examinations in determining the quality of a supply has been given considerable discussion in past years. The necessity for the so-called sanitary determinations has ranged from the viewpoint of the advocate of continuous and complete chemical analyses, as in Massachusetts, to the more radical exponents of the complete omission of sanitary chemical tests, as, for instance, the public health officials of Minnesota. The establishment of chemical standards for quality of water need not be gone into here in any detail, since both the methods and the accuracy of results in the field of water analysis are far more advanced than in the case of the bacterial tests. The problem in this instance, however, as well as in the case of bacterial standards, seems to lie more in the further study of the relative significance of data rather than in the establishment of meaningless standards based upon incomplete and variable manifestations of hidden phenomena.

Summary

The establishment of a standard of quality for potable waters means the setting up by some accepted authority of a rule for the measure of quality. Since quality is a variable attribute, intricately dependent upon a series of natural physical, chemical and biological phenomena, its measurement becomes extremely difficult. The quality of a particular water cannot, in most instances, be measured adequately by means of the evaluation of only one of its characteristics. The real consideration or interpretation of the potability of a supply involves a series of mutually active attributes, each of which plays a part of importance in modifying and determining the character of the water. Any scientific and practical standard must include, therefore, a composite of all those features which influence a change in quality. The single ultimate unit of measure or the final standard becomes, in this way, an index number of properly weighted individual and fundamental units.

The prime requisites for the establishment of any standard are the existence of those basic units which are to be its components and of universal agreement as to the relative significance of such components. In the field of water supply neither of the two above requirements has been fully met. Basic or fundamental units for measurement of quality have not been established with any degree of exactness or accuracy. A unit of measure, such as the B. coli content, certainly cannot be predicated upon such variable procedures as are now followed, without resulting in a confusion of interpretation. The establishment of any unit demands an absolute consistency in its measurement. It is this consistency of measurement which is now absent in practically every available measure of quality.

If inconsistency reigns in the determination of the fundamental units, such as the total count, the B. coli content, the chemical constituents, and the sanitary survey, then the general standard of quality, a derived unit composed of basic measures, becomes of extremely little value. If we add to this consideration of inconsistent method of obtaining individual units, the fact that their relative significance is still unsettled, then a general standard becomes practically useless and even misleading.

From the above discussion, it becomes clear that the study of the method of evaluating a unit must of necessity antedate the attempt to establish limiting values of such a unit. A critical survey of past standards of quality seems to indicate an assumption that the method of unit-evaluation is fixed, and therefore that limiting values are the desiderata. It is not felt that the status of laboratory or field method of analytical examination warrants any such assumption. The field for future standardization of quality of water supplies would appear to lie more immediately in the consideration of such problems as the relative significance of different bacterial counts, the methods of obtaining the counts, the necessary frequency of sampling, of plating, of numbers of fermentation tubes, the numerical interpretation of usual fermentation tube results, the allowable variations from specified bacterial contents, the determination of real bacterial indices to sewage pollution, the importance of chemical determinations, and the standardization of field survey methods. More remotely, the problem of standards is concerned with the coordination of the results of such studies as the above in such a way as to construct a composite unit of measure. Until these studies have been made and a general agreement reached, a standard would have but little value.

Estimates giving the cost of the proposed Mimico Creek concrete bridge for the Toronto-Hamilton Highway Commission, are being prepared by Geo. Hogarth, chief engineaer for the department of highways, and will be submitted to the Ontario Railway and Municipal Board at the next hearing, which is slated for May 31st.

CONVENTION OF CANADIAN CHEMISTS

In conjunction with the annual meeting of the Society of Chemical Industry held May 21st and 22nd in Ottawa, Ont., there was a convention of Canadian chemists. There were approximately 110 delegates, representing all parts of Canada and including academic, professional and industrial chemists.

There was a thorough discussion of possible organization for the improvement of the status of chemists and for the protection of the public. A popular idea was that the association should act as a registration body for all qualified chemists, and that legal recognition of chemistry as a profession should be secured from the Dominion Government. A committee was appointed to proceed with organization and to report at the next meeting. The members of this committee are:—

Prof. Parker (chairman), University of Manitoba; H. J. Roast (secretary-treasurer), Montreal; Prof. L. F. Goodwin, Kingston; Dr. A. McGill, Ottawa; Prof. McIntosh, University of British Columbia; Mr. Gregeroff, of Canadian Explosives, Limited, Montreal; Prof. Ardagh, Toronto; and Joseph Race, city bacteriologist and chemist, Ottawa.

Mr. Schorman, of Imperial Oil, Limited, and Dr. A. McGill read a paper on "Standardization of Gasoline." During the discussion following this paper, Dr. McGill announced that the Department of Inland Revenue are now preparing standards for gasoline, this action being due to the numerous complaints received. Dr. McGill claimed that all gasoline on the market would give satisfactory results if properly used, the complaints being due to imperfect knowledge on the part of the users rather than to the gasoline.

The delegates visited the mint, the fuel-testing laboratory and the other laboratories of the Mines Branch, the plant of the E. P. Eddy Co., and the new parliament buildings, where they were taken over the work by the architect, Mr. Pearson. The last-mentioned visit was made in conjunction with the members of the Royal Society.

At a dinner given on Wednesday evening, the officers of the Society of Chemical Industry for the ensuing year were elected. The new chairman of the Canadian section is Prof. W. L. Goodwin, of Queen's University, Kingston. Various phases of the chemical industry were touched upon in the after-dinner speeches. Among the speakers were T. H. Wardleworth, of the National Drug & Chemical Co., who spoke on Imperial Munitions Board chemicals; Mr. Davies, of the Standard Chemical Iron and Lumber Co., who gave an address on wood distillation products; and Mr. Hambly, of the Electro-Reduction Co., Buckingham, P.Q., who spoke on electro-chemical products.

Work on the new north arm bridge of the Fraser River, near Vancouver, B.C., has begun. A 140-ft. Howe truss span will replace the one that required repairs.

The Governor-General has signed the bill authorizing the change in name of the Canadian Society of Civil Engineers, and beginning May 27th that society officially adopted the new name, "The Engineering Institute of Canada."

St. Louis, Missouri, is having 400 miles of water mains cleaned by the National Water Main Cleaning Co., of New York City. Another United States city reports that the capacity of a mile of 10-inch water main was approximately doubled after it had been cleaned. This main had been in service seventeen months and had carried very hard water from artesian wells. The incrustation removed averaged 7½ lbs. per foot of pipe. It is true conservation to keep water mains clean.

CANADIAN SOCIETY OF CIVIL ENGINEERS ELECTIONS AND TRANSFERS

At a meeting of the council of the Canadian Society of Civil Engineers held in Montreal on Tuesday, May 21st, the following elections and transfers were announced:—

Adamson, Ernest Kinnear, of Stave Falls, B.C., elected an associate member. Mr. Adamson was born at Forfar, Scotland, in 1885. He took an engineering course at Heriot-Watt College, Edinburgh, Scotland, from 1903 to 1905. From 1914 to 1917 Mr. Adamson was engaged in the design of sewers, outfalls and dam for the Vancouver and Districts Joint Sewerage and Drainage Board, and since 1917 to present date resident engineer and superintendent for Western Power Co. of Canada at Stave Falls, B.C.

Allen, Robert William, of Regina, Sask., elected a junior member. Mr. Allen was born at Middlesborough, Eng., in 1889. Since 1908 he has been employed in the works department, Regina, in various capacities, since 1917 being assistant city engineer.

Bishop, John Murphy, of Montreal, Que., transferred from the class of student to junior member. Mr. Bishop was born at Montreal in 1894 and received the degree of B.Sc. in mechanical engineering at McGill University in 1916. At the present time he is demonstrator in the department of mechanical engineering, McGill University.

Bothwell, Robert Scott Clemens, of Windsor, Ont., elected a junior member. Mr. Bothwell was born at Toronto in 1894, and received the degree of B.A.Sc. at the University of Toronto in 1917. From 1916 to 1917 he was associated with the department of public works, Toronto, on harbor improvement work, and later in charge of all surveys, etc. At present Mr. Bothwell is on the engineering staff of the Canadian Steel Corporation, Limited, Ojibway, Ont.

Bridges, FitzJames, of Walkerville, Ont., elected a junior member. Mr. Bridges was born at Windsor, Ont., in 1887. From 1909 to 1912 he was with the Trussed Concrete Steel Co., and is at present in the district engineer's office, public works department, Windsor, Ont.

Brown, Donald Macdonald, of Edmonton, Alta., elected an associate member. Mr. Brown was born at Dundee, Scotland, in 1884 and received his education at the Morgan Academy and Technical College, Dundee. From 1906 to 1913 he was with the Grand Trunk Pacific Railway and from 1913 to 1916 with the Edmonton, Dunvegan and British Columbia Railway. Since 1916 Mr. Brown has been on active service.

Cassidy, John Francis, of Toronto, Ont., elected a junior member. Mr. Cassidy was born at Toronto in 1884. For some years he was associated with the Canadian Pacific and Canadian Northern Railways. In 1913-15 he was concrete inspector and assistant to C. MacN. Steeves with the Maritime Dredging and Construction Co. on construction of new wharves at St. John, N.B., and from 1915 to date, draftsman and assistant to John Sweeney, resident engineer, Toronto harbor improvements.

Collins, Charles Durham, of Brantford, Ont., elected a member. Mr. Collins was born at Peterborough, Ont., in 1872. He attended McGill University and the School of Practical Science, Toronto. He also took a special two-year course in mechanical engineering. In 1909-10 Mr. Collins was associated with the late J. J. Drummond, of Montreal, at Midland, Ont., and Geo. Macdougall, Dominion Steel Co., Sydney, N.S., on construction of a blast furnace at the Midland plant of the Canada Iron

Corporation, and was also in charge of erection and equipment of foundry for same company at Midland. During 1910-14 he was with the Waterous Engine Works, Brantford, Ont.; 1914-15 with P. H. Secord & Co., general contractors, Brantford, and from June 1st, 1915, to date, shell examiner.

Collins, Lawrence Edward, of Windsor, Ont., elected a junior member. Mr. Collins was born at Sherbrooke, Que., in 1893. He took a two-year course in civil engineering at Valparaiso University. At present Mr. Collins is with the Canadian Steel Corporation, Ojibway, Ont.

Crockard, Frank Hearne, of New Glasgow, N.S., elected a member. Mr. Crockard was born at Wheeling, West Virginia, in 1873, and received his education at Lehigh University and the Michigan College of Mines. From 1895 to 1897 Mr. Crockard was in charge of blast furnaces for the National Tube Co., Wheeling, W. Va. He was later assistant manager and afterwards manager of the Riverside Works, National Tube Co., until 1906; 1906-1917, vice-president, Tennessee Coal, Iron and RR. Co., Birmingham, Ala., and at the present time is president of the Nova Scotia Steel and Coal Co., New Glasgow, N.S.

Cummings, Alfred, of Fernie, B.C., elected an associate member. Mr. Cummings was born at Omemee, Ont., in 1880. He received his degree of B.Sc., at Queen's University in 1908. For some time past Mr. Cummings has been engaged in engineering work for the British Columbia government.

Fairbairn, Richard Purdom, of Toronto, Ont., elected a member. Mr. Fairbairn was born at London, Ont., in 1855. From 1877 to 1879 he was a member of the firm of Robinson, Tracy & Fairbairn, city engineers, London, Ont.; 1879, Public Works Department, Ontario, work included sewers and water supply, locks, dams, bridges and railway inspection, etc.; 1895-1910, assistant engineer Ontario government public works, later chief engineer; 1910 to the present time deputy minister, Public Works Department.

Hanson, Edward Christian Adair, of Saskatoon, Sask., elected an associate member. Mr. Hanson was born at Glasgow, Scotland in 1883, and took a four-year course in electrical engineering at the Glasgow and West of Scotland Technical College. In 1911 he was superintendent of construction for Canadian General Electric Co.; 1911-13, superintendent for Canadian Light, Heat & Power Co., Montreal; 1913 and at the present time city electrical engineer, Saskatoon, Sask.

Hogarth, George, of Toronto, Ont., transferred from associate member to member. Mr. Hogarth was born at Toronto in 1886 and graduated from the School of Practical Science, Toronto, in 1909. Since 1910 Mr. Hogarth has been with the department of public works, Ontario, and since 1916 has been chief engineer of highways.

Jacobson, Eric Anton, of Lindsay, Ont., elected a member. Mr. Jacobson was born at Stockholm, Sweden, in 1881. He took a three-year course at the Machine Technical College (Maskinyrkesskolan), Stockholm, Sweden, and studied hydraulics at die Technische Hochschule, Stuttgart, Germany. He also studied in the United States under State scholarship in 1904. From 1910 to 1915 Mr. Jacobson was hydraulic engineer with the Canadian Boving Co., Toronto, and later chief engineer with Boving & Co., of Canada, Limited, successors to the above company; 1915 and at the present time general manager of the Boving Hydraulic & Engineering Co., Ltd., Lindsay, successors to Boving & Co.

Kendall, Ralph, of Ojibway, Ont., elected a junior member. Mr. Kendall was born at Louisburg, C.B., in 1889. For some time he was associated with the Dominion Iron & Steel Co., Sydney, N.S., and is at present with the Canadian Steel Corporation, Ojibway, Ont., as chief of survey party.

King, John Albert Shirley, of Ottawa, Ont., elected an associate member. Mr. King was born at Peterborough, Ont., in 1882, and received the degree of B.Sc. at Queen's University (School of Mining) in 1909. For some time past Mr. King has been employed on work for the Dominion Government.

Marshall, John, of Regina, Sask., elected an associate member. Mr. Marshall was born at Eastbourne, Eng., in 1880. He enlisted in December, 1915, as private in the 68th Battalion C.E.F., went to France with the 2nd Field Co. C.E.

McKenzie, James Edgar, of Calgary, Alta., transferred from the class of student to associate member. Mr. McKenzie was born at Minneapolis, Minn., in 1889 and received the degree of B.Sc. at Queen's University in 1912. At present he is president and manager-director of J. E. McKenzie, Ltd., general contractors and engineers.

Pratt, George Robert, of Winnipeg, Man., elected an associate member. Mr. Pratt was born at London, Eng., in 1876. From 1906 to 1910 he was inspector and engineer on construction of C.P.R., Winnipeg shops, under J. E. Schwitzer, and from 1911 to 1918, mechanical and fuel engineer, western lines, C.P.R.

Puntin, James Henry, of Regina, Sask., elected an associate member. Mr. Puntin was born at Gatehead-on-Tyne, England, in 1878 and was educated at Gatehead and Owens College, Manchester, Eng., and Royal Institute of British Architects. From 1915 to 1917 Mr. Puntin was on active military service and at present is practising as architect.

Rannie, John Leslie, of Ottawa, Ont., elected an associate member. Mr. Rannie was born at Newmarket, Ont., in 1886 and received his degree of B.A.Sc. at the University of Toronto in 1909. Mr. Rannie is at present supervisor of triangulation on Geodetic Survey of Canada.

Reilly, Francis Bell, of Regina, Sask., elected an associate member. Mr. Reilly was born at Wardsville, Ont., in 1874. From 1909 to date he has been a member of the firm of Reilly, Dawson & Reilly, architects, surveyors and engineers, Regina.

Smaill, William, of Winnipeg, Man., elected a member. Mr. Smaill was born at Montreal in 1870 and received his degree of B.A.Sc. at McGill University in 1890. At the present time Mr. Smaill is general superintendent of the Winnipeg Aqueduct Company.

Smith, William Raymond, of London, Ont., elected an associate member. Mr. Smith was born at Toronto, Ont., in 1888. From 1912 to 1913 he was in private practice for Coté, Tremblay & Pearson, civil engineers, Edmonton; 1913-14, resident engineer, Edmonton, Dunvegan & British Columbia Railway, and at the present time lieutenant, C.E.F., at Engineers' Training Depot, St. Johns, Que.

Somers, Newton L., of Sault Ste. Marie, Ont., transferred from junior member to associate member. Mr. Somers was born at Villa Nova, Ont., in 1888, and received the degree of B.A.Sc. at the University of Toronto in 1914. In 1913 he was draftsman and designer with James, Loudon & Hertzberg, Toronto; 1914-15, inspector of erection of bridges and building with the Canadian In-

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The Engineer's Library

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HAND BOOK OF HYDRAULICS

Reviewed by Thos. Hogg
Asst. Hydraulic Engineer, Ontario Hydro-Elec. Power Com.

By *Horace Williams King*, Professor of Hydraulics, University of Michigan. Published by the McGraw-Hill Book Co., New York City, and Hill Publishing Co., London. First edition, 1918. 424 pages, 112 tables, 90 figures, 4 x 6¾ ins., cloth. Price, $3.00.

A knowledge of the fundamental principles of hydraulics is presupposed in this volume, which is a compilation of the commonly accepted formulæ, together with a certain amount of new information. It is intended primarily to assist in the solution of hydraulic problems and should aid the practising engineer in making the most reasonable application of the available data to each specific problem he meets.

The several chapters comprise the following subjects: Hydraulic units, hydrostatics, orifices, sharp crested weirs, weirs not sharp crested, flow of water through pipes, flow of water in open channels, measurement of flowing water, special problems, general reference tables, comparison of weir formulæ with experiments, comparison of Kutter and Manning and Bazin formulæ with Scobey's experiments.

This little handbook should prove invaluable to the engineer dealing with hydraulic problems. It is the best of hydraulic handbooks published to date.

TECHNICAL MECHANICS

Reviewed by Prof. E. Brown
McGill University, Montreal

By *Edward R Maurer*, Professor of Mechanics, University of Wisconsin. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. Fourth edition. 381 pages, illustrated, 6 x 9 ins., cloth. Price, $2.50 net.

This edition of Maurer's Technical Mechanics is practically a rewritten book, many changes, both in the form of omission and addition, having been made. It is evidently the outcome of an earnest endeavor to present to the student of engineering science those fundamental principles of mechanics which underlie an intelligent study of the many problems which he has to face, and in the main the object has been well attained. Ten years' experience of the use of the earlier edition in the author's classes suggested many changes, and new examples have been developed suited to a course of instruction in an engineering school. These examples, numbering nearly four hundred, have been embodied at the end of the present volume, with references to the articles in the text which bear most directly upon the principles involved. They have been selected admirably, and the student of mechanics who can work successfully through them will have a thoroughly sound knowledge of the application of mechanics to technical problems. One regrets that answers are not given to the numerical questions, but the regret is tempered somewhat by the reflection that, after all, this is really a book for the student following a course under a capable teacher, and that a judicious selection of problems will be made, and worked out as a part of such a course. This is not to imply that an isolated student, assuming him to have the necessary knowledge of elementary mechanics and mathematics (including the calculus), would not benefit greatly by a study of this book. But for such, the addition of answers would be the greatest boon, and perhaps they may be added to later editions.

Referring to the text itself, the subject is treated in the order which most teachers find necessary, so that statics come first and then dynamics. The analytical conditions of equilibrium of systems of forces are clearly set forth and graphical methods are used freely. Throughout the various articles, examples are worked in illustration of the principles enunciated, and these are well chosen to fulfil the double purpose (*a*) of driving home the principle and (*b*) of giving the student a clear perception of the usefulness of the principle in his technical work. Attention is drawn to statically indeterminate problems, and to the futility of attempting to solve them by the conditions of statical equilibrium.

Succeeding chapters deal with friction, including wedges, screws and belts, and with centre of gravity and the problems met with in loaded suspension cables.

Much might be said in commendation of the later chapters dealing with dynamics, for in them there is evidence of endeavor to present *real* principles to students in connection with the dynamics of a rigid body. Too frequently, in this connection, "mechanics for engineers" means only the acquisition of certain formulæ written down by analogy from the equations of motion for a particle, in conjunction with an elementary treatment of moments of inertia. Pope said long ago that "a little learning is a dangerous thing," and this is profoundly true in the application of mechanics to technical engineering problems. Professor Maurer, however, devotes much space to a progressive treatment of the motion of a rigid body, giving simple illustrative examples wherever possible, but keeping close to his main object of presenting a logical statement of the fundamentals of the subject. Problems on rotating bodies, impulse, centre of percussion, compound pendulums, etc., are introduced, and there is a section dealing with the phenomena of the gyroscope and some of its applications such as in the gyroscopic compass, the steering of torpedoes, and the mono-rail car. An analysis of the theory of the gyroscope, suited to the degree of attainment of those who have mastered the principles previously explained, is also given.

Many references are given throughout the book to standard text-books in which matters under consideration are treated more completely. Appendices deal with the dimensions of units, and with moment of inertia of plane areas. This section also includes the product of inertia

of areas, and one welcomes this, as it is a quantity entering into problems on the bending of unsymmetrical sections, and is too frequently ignored.

Minor criticisms would be out of place where there is so much to be commended, but the reviewer, in paying tribute to the many merits of this book, regrets that Prof. Maurer countenances the "slug" and the "gee-pound." These nicknames for the so-called "engineer's unit of mass" are not really needed. Engineers who understand mechanics do not have to think in terms of engineer's units of mass, and those persons who do not understand mechanics are not really helped by the introduction of any such special unit. They "get the answers" in terms of units used by engineers if they can "just remember where that 'g' comes in," but their understanding is in no sense broadened by the achievement. Engineers must, of course, continue to use the pound as their unit of force, and the "engineer's unit of mass," while unnecessary, has probably come to stay, but we do not need the "slug" and the "gee-pound." The reviewer considers that the "slug" is a nasty, disagreeable thing—its proper place is underground.

THE STRENGTH OF SHIPS

Reviewed by W. B. Macdonald
Plant Engineer, Canadian Aeroplanes, Ltd., Toronto

By *J. Bertram Thomas, A.M.Inst.C.E.* Published by Scott, Greenwood & Son, London. 295 pages, 114 diagrams, 31 tables, $4\frac{3}{4} \times 7\frac{1}{2}$ ins., cloth. Price, $1.25 net.

The books dealing with this subject at a moderate price are few in number, so this book should certainly be appreciated. The ground work of the book is a series of chapters dealing with beams, strength and flexure under various loadings, and is well written and instructive, the most interesting of the series being the one dealing with sheer stresses. It would be very difficult to write something new about beams, considering the amount of space devoted to this subject in engineering handbooks. The stresses set up in rectangular plates under water pressure and the relationship between stiffeners and plate are very ably dealt with, as is also the criticism of the various formulæ dealing with the strength of columns. Much useful information is given in that part giving approximate methods for finding a tentative load curve.

The book suffers a little owing to the want of care taken with the diagrams, both as regards clearness, size, lettering, and, in some cases, their place with regard to the text. The student might well ask, when he looks at the formulæ on page 249: "Force at $A = \frac{2 (60 \times 46) \times 20 \times 36}{12 \times 19} = 27.4$ tons," and Fig. 112, on page 250, where is *A*? Is the figure a plan or an elevation? Is the deck the cambered line, or does the deck lay on the same plan as the page? What depth is the girder shown on Fig. 113?

The strength of submarines can only have an academic interest to us here, but the subject of gun-mountings will be greatly appreciated, and might have been with advantage enlarged upon.

Only the outstanding features of the book have been mentioned, but the book is generally well written and easy to understand. It will make a splendid companion volume to, say, Attwood's "Theoretical Naval Architecture" and Walton's "Know Your Own Ship."

It might be noted that the ton used is the gross ton (2,240 lbs.), and that where the figure 35 is used it refers to the cubic feet of salt water in a gross ton.

PETROLEUM IN CANADA

By *Victor Ross*, financial editor of the Toronto Globe, Toronto, Ont. Published by the author. First edition. 109 pages, 102 illustrations, 5 x 8 ins., cloth. Price, $1.00 net.

This little volume gives a very interesting non-technical history of the oil industry in Canada. The facts are well condensed, yet presented in an interesting and readable manner, statistics being generally avoided, and dry facts concerning dates and names being relieved throughout by clever treatment and by a touch of the romance and adventure that has always accompanied the oil industry. Besides the introduction, this work is divided into eleven chapters, of which the titles are:—

Theories of the Origin of Petroleum; Petroleum Industry in Western Ontario; Early History of the Western Ontario Oil Fields; Drilling and Shooting of Oil Wells; Methods of Storing and Refining; Boom Days in Alberta; Petroleum in Western Canada; Petroleum in Eastern Canada; Companies, Refineries and Individual Producers; Some Products and Uses of Petroleum; Future of the Industry in Canada.

"Our own production at present," says the author, "is not merely an insignificant contribution to the world's output, but a small part of our own consumption. From 1865 to 1870 the yield in the Western Ontario field was about 200,000 barrels annually. The export demand produced wide fluctuations in the production and brought the output up to half a million barrels per year at times, until 1877. There ensued successive increases and declines until 1907, when the production reached 800,000 barrels, which would appear to be the maximum for the Canadian field."

Imperial Oil, Limited, of Toronto, have purchased a number of copies of this book, which they are distributing to their friends and customers.

Subsequent to the publication of this book, the author has been offered and has accepted a position as assistant to Walter C. Teagle, president of the Standard Oil Co., of New Jersey, who was president of the Imperial Oil Co. when this book was being written.

A TREATISE ON ROADS AND PAVEMENTS

Reviewed by W. A. McLean
Deputy Minister of Highways, Province of Ontario

By *Ira Osborn Baker, C.E.*, Professor of Civil Engineering, University of Illinois, Urbana, Ill. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. 667 pages, 235 illustrations, 80 tables, 6 x 9 ins., cloth. Price, $4.50.

This is the third edition of a work first published in 1902. Progress in road and pavement design and construction during the past sixteen years has necessitated numerous radical changes in the text of the first edition, and the present edition, now up to date, should be of considerable value as the author has been intimately familiar with the development of the art.

The book is divided into two parts. The first part, consisting of ten chapters, is devoted to the subject of country roads, and the second part, also of ten chapters, to street pavements. As the author states in his preface, the present edition has been thoroughly revised and entirely re-written. Five chapters of minor importance have been omitted to allow for an equal number of new ones, and attention has been given to materials and forms of construction that affect the quality and cost of the road and pavement.

The chapter headings are as follows: Country Roads, Part I.—Road Economics and Road Administration; Road Location; Earth Roads; Sand and Sand-Clay Roads; Gravel Roads; Waterbound Macadam Roads; Portland Cement Concrete Roads; Bituminous Road Materials; Bituminous Surfaces for Roads; Bituminous Macadam and Bituminous Concrete Roads.

Street Pavements, Part II.—Pavement Economics and Pavement Administration; Street Design; Street Drainage; Curbs and Gutters; Pavement Foundations; Asphalt Pavements; Brick Pavements; Stone-Block Pavements; Wood-Block Pavements; Selecting the Best Pavement.

The subject of curves on country highways is very clearly defined in the chapter on road location, as also are location and re-location.

The chapter on cement concrete roads is most complete in its description of this type of road, thirty-nine pages being devoted to the subject. The advancement of such a surface has been rapid, the square yardage laid in the United States at the end of 1916 being forty-eight times as great as that laid at the end of 1909.

The eighth chapter deals at length with the subject of bituminous road materials, an added feature to the first edition. Chapters nine and ten are devoted to bituminous surfaces and bituminous macadam and concrete roads. These surfaces are thoroughly digested and are up-to-date in every detail. During the past ten years successful experiments have been carried out with both asphalt and tar products.

The subject of asphalt pavements dealt with in chapter sixteen has been much revised and enlarged to take care of the development made in the various types of this class of pavement. The various types, including asphaltic concrete, stone-filled sheet asphalt, Topeka mixture and several patent mixtures are all thoroughly discussed. Tables are given showing the standard gradings of the mineral aggregate in these pavements, together with recent costs of constructing and maintaining same.

In chapter fifteen, dealing with the subject of pavement foundations, valuable suggestions are to be found, with the addition of several pages on the construction of street railway tracks. Chapter seventeen discusses all the essential features of brick pavements and a valuable revision of the subject is contained therein, including the wire cut-lug hillside block. Special information concerning stone and wood-block pavements is to be found in the chapters relating to these pavements. The tables showing the cost of constructing these pavements are very explicit and the illustrations are instructive. Chapter twenty deals with the subject of selecting the best pavement and contains data on the solution of the problem.

The book is intended rather for the road engineer and the inspector than for the contractor. The style throughout is simple and practical, and the illustrations make the meaning abundantly clear. It would be impossible in a review to give many details of the contents of this book; it must suffice to say of the present edition that the revision makes it even better than its predecessors and that it has been most carefully and concisely written.

EVAPORATING, CONDENSING AND COOLING APPARATUS

Reviewed by A. S. L. Barnes
Hydro-Electric Power Commission of Ontario, Toronto

By *E. Hausbrand*, translated by *A. C. Wright, M.A., D.Sc.* Published by Scott, Greenwood & Son, London. Second English edition, 1916. 401 pages, 76 tables, 21 figures, $5\frac{1}{2}$ x $8\frac{3}{4}$ ins., cloth. Price, $3.00 net.

The first German edition of this book was published in 1899 and was translated by Mr. Wright in 1902; the present volume is a translation of the second German edition of 1900.

Some errors which previously appeared have been corrected and conversion diagrams have been added for changing metric units into British ones.

The German author, in his preface, says: "The constant motive in writing this treatise has been the desire to provide as complete and reliable assistance as possible for the solution of the problems of the construction and working of apparatus for evaporating, condensing and cooling.

It would appear that a good attempt has been made to realize this object.

The earlier chapters discuss the fundamental principles governing heat transmission from solid to liquid and vice versâ, and formulæ for these are developed in a clear manner.

Practical problems are dealt with later on and as a help to the reader very numerous tables are provided giving the values of many formulæ for varying conditions. Some of the subjects included are: Evaporation by means of hot liquids, multiple effect evaporations, the diameter of pipes for steam, alcohol vapor and air, condensers, the cooling of liquids.

For the engineer possessing a moderate knowledge of mathematics, engaged in designing such plant as is dealt with, this book should be of considerable use.

MATHEMATICS FOR ENGINEERS—PART I.

Reviewed by A. S. L. Barnes
Hydro-Electric Power Commission of Ontario, Toronto

By *W. N. Rose*, B.Sc. Published by Chapman & Hall, Limited, London, 1918. 510 pages, 11 tables, 257 figures, $5\frac{1}{2}$ x $8\frac{3}{4}$ ins., cloth. Price, $2.25 net.

This book is one of the "D.U." or "directly useful" technical series of which a former work, "Arithmetic for Engineers," was reviewed in these pages some little time ago.

The author states in his preface that "an endeavor has been made to produce a treatise so thorough and so complete that it shall embrace all the mathematical work needed by engineers in their practice and by students in all branches of engineering science."

The field as outlined above being so extensive, the work has been divided into two volumes. Part I. deals with the fundamental rules and processes of algebra, plane trigonometry, mensuration and graphs; Part II. will take up the calculus and its applications, etc.

This book is very carefully graded and takes the reader step by step through each section, and if the reader finds that any point has not been thoroughly grasped, a revision should soon set this right as the explanations are clearly given and numerous examples worked out. The principle of the book is evidently to plunge into practical applica-

tion of the various algebraic and other rules as soon as possible after these have been explained and the author has succeeded well in carrying out his intention, as expressed in the quotation given above from the preface, so far as the ground covered by Part I. goes.

A special feature is Chapter I., "Aids to Calculation," in which a number of useful and handy methods are given for getting at rough approximations to the answers to problems, so that, for example, the placing of the decimal point in the answer found by slide rule will be simplified.

There are few engineers who would not find this book a great convenience either for the purpose of refreshing their memories or for extending their knowledge beyond existing limits.

If the editor of this series, W. J. Lineham, is successful in obtaining, for all his publications, the services of men who will write works of as much practical utility to engineers as this one by Mr. Rose, they are sure of a welcome. It should be stated that some acquaintance with the elementary principles of algebra, on the part of the reader, is assumed; also a knowledge of the slide rule.

PUBLICATIONS RECEIVED

Report of the Director of Forestry for 1917.—Issued by Forestry Branch, Department of the Interior, Canada.

Concrete Pressure Pipe.—Brochure issued by the Portland Cement Association, Chicago. Sent upon request.

Crouch Steel.—A sixteen-page brochure published by W. J. Crouch Company, Incorporated, 253 Broadway, New York City.

Wheeler Centrifugal Pumps.—Bulletin 108-B. Illustrated catalogue issued by the Wheeler Condenser and Engineering Company, Carteret, New Jersey.

The Levin Oxygen and Hydrogen Generator.—Bulletin G, issued by the Electrolytic Oxy-Hydrogen Laboratories, Inc., 15 William Street, New York, N.Y.

A Study of the Heat Transmission of Building Materials.—By A. C. Willard and L. C. Lichty. Bulletin No. 102, Engineering Experiment Station, University of Illinois, Urbana, Ill. Price, 25 cents.

More and Better Water for Our Farms.—Report of a conference called by the Lethbridge Board of Trade at Lethbridge, Alberta, on June 22nd, 1917. Issued by the Commission of Conservation, Ottawa, Ont.

The Storage of Bituminous Coal.—By H. H. Stock, professor of mining engineering, University of Illinois. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Price, 40 cents.

Transactions of the Institute of Marine Engineers.—Containing a paper on "Aids to Prevent a Ship from Sinking," by Charles V. A. Eley, and discussion on same. Published by the Institute, The Minories, Tower Hill, London, Eng.

Canadian Douglas Fir—Its mechanical and physical properties. Prepared under the direction of J. S. Bates, Chem.E., Ph.D., superintendent of Forest Products Laboratories of Canada, by R. W. Sterns, B.Sc., chief of Division of Timber Tests. Bulletin No. 60, Forestry Branch, Department of Interior, Canada.

Report of Annual Meeting of Ohio Engineering Society.—Containing papers on "Brick Pavement Construction in Cleveland," by F. R. Williams; "Road Maintenance and Repair," by A. H. Hinkle, State Highway Department; and "Industrial Housing and Town Planning," by Morris Knowles and Geo. W. Case. Secretary-treasurer of the society, John Laylin, Norwalk, Ohio.

Poor's Manual of Industrials for 1918 has just been issued. The general information is revised to April 18th. It contains the latest income accounts and balance sheets of all industrial companies in which there is a public interest. These are in most cases presented in a comparative form, showing at a glance the growth of the business. This is the first book issued that gives complete information regarding the present United States income tax on industrial securities. It states whether the companies assume a 4% tax or only a 2% tax or no tax at all. The book is invaluable to those who are interested in industrial securities. Published by Poor's Manual Co., 80 Lafayette Street, New York. Price, $10 a copy.

ENGINEERING INSTITUTE AT HAMILTON

While attending the first general professional meeting of the Engineering Institute of Canada, which was held in Toronto a couple of months ago, Secretary Keith, of the institute, held a conference with a number of members from Hamilton, including E. R. Gray, the city engineer, regarding the possible establishment of a Hamilton branch of the institute. Mr. Gray undertook to discuss the subject with the other members in Hamilton and to find out whether it would be advisable to attempt the organization of a branch in that city. Meanwhile Mr. Keith brought the matter to the attention of the council of the institute, who endorsed the proposal. As a result it has been arranged for the secretary to go to Hamilton during the week of June 9th, in order to meet the members resident in that city, and to perfect the details of the organization.

CAN. SOC. C.E. ELECTIONS AND TRANSFERS

(Continued from page 490)

spection Co., Toronto Suburban Railway, C.N.R., Ottawa Capreol Line, etc.; 1915-16, assistant to Jas. S. Galletley, D.L.S., on government settlement lot survey in Manitoba; 1916 to the present time as coke plant engineer, Algoma Steel Corporation on extension and rebuilding of the plant.

Stansfield, Edgar, of Ottawa, Ont., elected a member. Mr. Stansfield was born at Bradford, Yorkshire, England, in 1878, and received the degree of B.Sc. in 1910, and M.Sc. in 1903. Since 1907 to the present time he has been in charge of the fuel-testing chemical laboratories of the Department of Mines, Ottawa.

Warren, William Robert, of Regina, Sask., elected an associate member. Mr. Warren was born at Taunton, Eng., in 1876. In 1908 he was engineer in charge of the telephone system in the province of Saskatchewan, and since 1912 chief engineer, department of telephones in that province.

Wright, William Gordon, of Ottawa, Ont., elected a junior member. Mr. Wright was born at Montreal, Que., in 1891. He received a first class certificate in mechanical drawing at Kent, Eng., and is at the present time assistant to consulting naval engineer, department of naval service, Ottawa.

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Principal Contents of this Issue

ENGINEERING FAILURES

PROGRESS in any sphere of activity is often achieved by failure rather than by success, and he is a poor engineer, or at least a small-gauged one, who never makes a mistake or experiences a failure. If mistakes are not made unnecessarily and the lessons which they teach are not neglected, they are a most important part of an engineer's experience; oftentimes more can be learned from them and greater benefit can be derived for the planning and carrying out of new work, than from all the successful work one has ever done. The contribution which failures make to successful work is no mean one.

It doesn't follow always that mistakes and consequent accidents in connection with the carrying out of any engineering undertaking can be laid at the door of incompetence and bad judgment; they are in many cases incidental to new ways and unknown conditions and are really part of the price that has to be paid for improved efficiency, rapidity and economy.

All we know or have has come to us through either our own experience or the experience, good will and initiative of others, and we should therefore be glad to pass along to others the lessons that our failures teach us.

Publishers of technical papers are usually able to obtain, sooner or later, illustrated descriptions of engineering work successfully done. On the other hand, memory fails to record any great degree of success in securing articles descriptive of failures or mistakes. Is it not reasonable to suppose that except in flagrant cases, descriptions of construction troubles and their remedies benefit very much more than injure the interested parties, and that they will ultimately prove of more lasting value to the profession? One's own mistakes as well as those of his neighbor can be made to serve a useful purpose; they at least sound a warning which enables the entire profession to side-step danger points, and the profession is certain to be duly grateful for the information.

While the tendency is ever to put on the soft pedal when a failure takes place, it is open to question whether this invariably is the wisest course to follow in the best interests of engineering as a profession.

RESEARCH COUNCIL'S PLANT FOR MANUFACTURE OF LIGNITE BRIQUETTES

FROM the poorest quality of lignite coal in Canada, the Honorary Council for Scientific and Industrial Research intends to manufacture carbonized lignite briquettes. A plant costing approximately four hundred thousand dollars will be constructed at once near Estevan, Saskatchewan. The proposal is to take two tons of the poorest lignite in the world, having about 32% of moisture and 7,300 B.t.u. per pound, and turn them into one ton of briquettes having 5% moisture and 12,000 B.t.u.

In the Northwest there is a demand for anthracite to the extent of about five hundred thousand tons per annum, for which the consumers are willing to pay from ten to twenty dollars a ton in order to get clean fuel. The Research Council proposes to manufacture anthracite, or its equivalent, in Canada for about half these prices, using for the purpose two waste materials: lignite of such poor grade that it cannot be stored or shipped; and sulphite liquor.

Sulphite liquor will be used as the binder; it is smokeless and odorless. This liquor is the waste product from our pulp mills. Its use will result in the production of what the United States government in its tests has demonstrated to be at least the equal of anthracite in burning quality.

If the Research Council succeeds in this enterprise as it is confident it will succeed, the Council will have accomplished a fine stroke of true conservation,—the production of a valuable domestic fuel from two practically waste materials; as the only function of the sulphite liquor today is to poison the fish in our streams, and the lignite slack is a powder which cannot be shipped.

The Research Council has stated that this is not a laboratory experiment nor even a super-laboratory experiment, as the work has been done. Briquettes to the extent of a number of carloads have been manufactured from the identical lignites that will be used. The present undertaking is for the purpose of demonstrating the commercial feasibility of the project in a full-size plant; to test the commercial success of selling the product in the open market and through the present dealer channels.

The coal interests of Alberta are said to be inimical to this briquetting project for fear that it will interfere with the market in Winnipeg which they have been trying to capture for the past twenty years. The Alberta interests will be benefited if the Research Council's project succeeds, because they will then be able to follow suit and briquette their slack, thus keeping their mines in operation during the summer months and producing a better domestic fuel than they are offering in Winnipeg at present.

Estevan was chosen as the site for the briquetting plant largely on account of freight rates. It was desired to locate the plant as conveniently as possible to the largest market and in the centre of an adequate supply of lignite. The quality of the lignite does not particularly matter, as satisfactory briquettes can be made from the

poorer material, thus effecting greater conservation. If the process succeeds technically with the poorer lignite, there can be no doubt that suitable briquettes could later be made with the better lignite; but freight rates will have more effect upon the commercial success of the first plant than will the quality of the lignite used.

To defend themselves against possible short-sighted or uninformed criticism, the Research Councillors are now said to be printing a pamphlet discussing in detail the whole project.

PERSONALS

Robert Alexander Ross, E.E., has accepted the appointment of city commissioner of Montreal which was made recently by the government of the Province of Quebec. Mr. Ross was born August 28th, 1865, in Woodstock, Ont., and graduated from the University of Toronto in mechanical and electrical engineering. He started as an engineering apprentice with the firm of Robert Whitelaw & Co., Woodstock, Ont., later becoming works engineer of the Canadian General Electric Company at Peterborough, which firm he left to become chief engineer of the Royal Electric Company of Montreal, now called the Montreal Light, Heat and Power Co. Mr. Ross soon engaged in private practice, however, and has had a consulting office in Montreal for many years. He has now closed his office in order to devote his entire attention to his new civic duties and to the work of the Honorary Advisory Council for Scientific and Industrial Research, of which he is a prominent member. At various times Mr. Ross has been consultant to the Hydro-Electric Power Commission of Ontario, the Canadian Pacific Railway, the Hydro-Electric Power System of Toronto and to various cities and towns in the United States, Canada and abroad. He is the author of "Engineering Economics," and of various lecture notes for students at McGill College. Upon four different occasions Mr. Ross has been elected as a member of the council of the Canadian Society of Civil Engineers, and was vice-president of that society during the years 1914, 1915 and 1916. He is a fellow of the American Institute of Electrical Engineers, a member of the American Waterworks Association, and commodore of the Royal St. Lawrence Yacht Club, Montreal. Mr. Ross will be one of five commissioners who will have thoroughly autocratic powers for at least several years to come in managing the business of the city of Montreal. This commission will be independent of the mayor and council of the city and will be responsible for bringing all the civic affairs of Montreal out of the chaos into which they have been plunged in past years. The financial situation, the police force and the vice situation present the worst difficulties, but there will also be many problems to solve in the public works administration. The new commission's first stroke of business was to increase taxes 50% in order to make up deficits in the revenue. The commissioners have appointed heads for the four sections under which the work of the city, aside from financial matters, will be grouped. Paul E. Mercier, B.A.Sc., who has been city engineer of Montreal for several years, will be in entire control of public works; Chief Tremblay, of the fire department, will have charge of public safety; Dr. S. Boucher will superintend public health; and Senator David will head the secretarial department.

Sidney Johnson has been appointed city engineer of Stratford, Ont., in place of Lieut. A. B. Manson, who was granted leave of absence.

S. B. Wass, assistant superintendent of the Intercolonial Division, Canadian Government Railways, at South Devon, N.B., has been transferred to the engineering department at Moncton, N.B.

John C. K. Stuart, who was formerly a member of the engineering staff of the Montreal Tunnel and Terminal Company, has enlisted with the Royal Engineers. Mr. Stuart has latterly been in the employ of the Ford, Bacon & Davis Corporation, New York City.

Dr. W. G. Miller, Provincial Geologist of Ontario, has left for London, England, to attend the first meeting of the Imperial Mineral Resources Bureau. This bureau will have important duties in co-ordinating the mineral wealth of the various portions of the British Empire both during and after the war. The Federal Government appointed Dr. Miller as the Canadian representative on the bureau.

Major Charles Flint, B.A.Sc., University of Toronto, '10, has been awarded the Croix de Guerre for gallant and distinguished service with the 4th Battalion, Canadian Railway Troops. He was following his profession as assistant engineer of the C.P.R. at Winnipeg, when he enlisted with the rank of lieutenant in a Canadian Railway Construction Corps, and has been twice promoted while serving with his present battalion.

Major T. R. Loudon, professor in the Faculty of Applied Science and Engineering at the University of Toronto, who was invalided to England in January after prolonged service in France, has arrived in Canada on leave. He took his B.A.Sc. degree in 1905, and at the time of his enlistment, in addition to the academic appointment, was a member of the firm of James, Loudon & Hertzberg. Originally a lieutenant in No. 1 Can. Construction Battalion (now 1st. Can. Ry. Batt.), he was promoted captain and adjutant while on active service, and won his majority in France. Major Loudon, who is a son of Professor W. J. Loudon, of University College, was mentioned in despatches early this year.

COLONEL GEORGE G. NASMITH

IN the personal column on this page of last week's issue, mention was made of the new degree earned by "Lt.-Col." George G. Nasmith. This military title was an error, as Dr. Nasmith is no longer a lieutenant-colonel, but is now a colonel, having been promoted fifteen months ago on the field.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

DIONIC TESTER IN WATERWORKS SERVICE

Portable Apparatus Permits of Quick and Easy Determination of Source of Suspected Flows Where the Municipal Water Supply is of Markedly Different Conductivity than the Ground Water—Relation Between Conductivity and Bacteriological Purity

By JOSEPH RACE

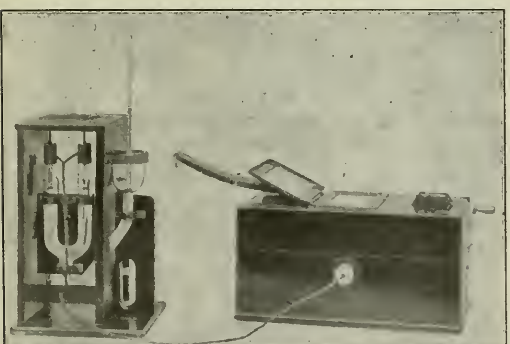
City Bacteriologist and Chemist, Ottawa, Ont.

ORIGINALLY, the Dionic water-tester, a portable apparatus designed for the determination of the electrical conductivity of water, was devised as a rapid and reliable method for detecting leakages of cooling water into surface condensers.

It was later suggested that it could be used for the detection of sewage pollution in water, but experimental work has shown that except in cases of gross pollution, the conductivity method is of little value. There are other purposes, however, for which the apparatus has been found to be of considerable value in the writer's laboratory, viz., the detection of leakages from mains; the estimation of mineral matter in natural waters; and the examination ot distilled water.

Detection of Leakages from Water Mains

It is often desirable to determine the character of water in order to ascertain whether it is due to leakage from a water main or service, or is derived from a spring or other natural source. For this purpose the conductivity method will be found to be of great assistance when the conductivity of the public supply is materially less than that of the natural waters. The conductivity of the Ottawa supply is usually about 50 units, a unit

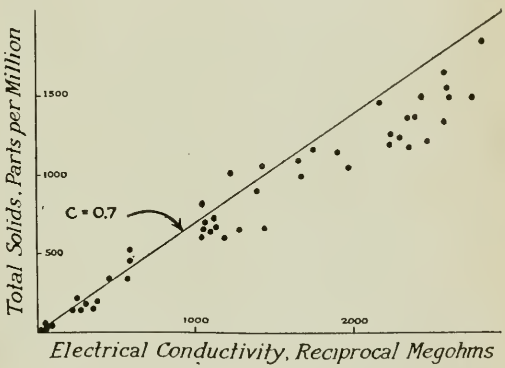


The Dionic Water Tester

being one reciprocal megohm, and it has been found that ground and spring waters never give a value of less than 200 units. The difference, 150 units, is so large that there is no danger of mistaking one source for the other.

This test, which requires only a very short time for completion, has been applied in Ottawa for several years with marked success, and has detected leakages which aggregate over one million gallons per day. In other cases, where water was suspected to be due to leakages, the test has shown it to be ground water and has saved the cost of exploratory digging.

One typical example of the detection of leakages might be cited. A stream of water issued from the face



of a hill for many years, and was always thought to be ground water finding its way from one of the many fissures of the limestone strata. A sample was tested in the conductivity apparatus and was reported as tap water. The stream was followed up and was found to be due to a leakage amounting to 300,000 gallons per day from a water main.

The only ambiguous results that have been encountered were caused by leakages travelling considerable distances and dissolving sufficient salts from the sub-soil to increase appreciably the electrical conductivity. Such cases have been very small in number and do not seriously detract from the value of the method.

The Dionic water-tester is by no means to be regarded as a substitute for pitometer or aquaphone surveys, but as a complement to them. Leakages that escape to drains and fissures, and which do not appear again, can be found only by the pitometer or aquaphone. But any visible water that cannot be accounted for should be tested for conductivity and its source established.

Estimation of Mineral Matter in Water

The electrical conductivity of water is caused by the presence of ionized salts in solution, and, as the great majority of the salts present in natural waters are com-

pletely ionized, the conductivity method has been proposed as a rapid way of estimating the inorganic solids. Certain German sanitarians who have experimented with this process, have stated that the mineral matter is directly proportional to the conductivity, and found that the factor c was approximately 0.7. The factor $c = m/e$, m being the mineral matter in parts per million, and e being the electrical conductivity in reciprocal megohms.

The writer has determined the value of c for a number of surface and subsurface waters of the Ottawa district, and some of the results are plotted in the accompanying diagram. A number of the results have not been plotted because they would have crowded the sketch too much in one spot. Most of these were of the Ottawa River at various stages and are so close together that there seemed to be no object in plotting them, considering the purpose of the diagram. A few other results not plotted were of saline waters which gave results far outside the limits of the diagram. These saline waters are extreme cases which are very rarely encountered.

It will be seen that c is by no means constant, and although the average of seventy determinations gave a value of 0.65, the variations from the mean are very considerable and invalidate the accuracy of the process as an indirect one for estimating the mineral content of water.

A similar result could be predicated from a consideration of the theoretical principles involved. The specific conductivity of an aqueous solution of an electrolyte is determined by three factors, viz., the concentration; the electrolytic dissociation; and the mobility of the ions.

The concentration is the predominating factor, but the nature of the dissolved substances also exerts an appreciable influence. Chlorides, sulphates and nitrates are practically dissociated completely when present in amounts up to 1,000 parts per million, but the dissociation of carbonate of lime commences to fall at a much lower concentration. At 100 parts per million the value of c for chalk is 0.40, but at 500 p.p.m. it is 0.47.

The conductivity is a function of the concentration of the ions, and also of their mobility, which is determined by the nature, the hydrogen ion being much more mobile than those of Na, K, Mg, Ca, Cl, SO_3, and NO_3, which also have different ionic velocities under a constant potential gradient.

The conductivity results are of value, however, in the classification of the source of supply, and frequent examinations of well waters have shown that there is often a correlation between the bacteriological purity and changes in the electrical conductivity. Deep wells, of great purity, have given a remarkably constant conductivity, whilst wells showing intermittent pollution have given varying conductivities. One well in Ottawa yields a water of good quality when the conductivity is about 2,000 units, and shows excessive pollution at 200 units. These results point to contamination with surface water, which gains access through a faulty casing pipe.

Wells yielding two different classes of water have been noted. One well, when the consumption is normal, supplies a chalk water having a conductivity of about 700 units; when the draft is very heavy, a saline water with a conductivity of 20,000 to 25,000 units is obtained.

Examination of Distilled Water

As absolutely pure distilled water is a very poor conductor of electricity, the conductivity method is very suitable for its examination. By employing special precautions, distilled water can be prepared having a conduction of less than one unit, but the ordinary product made in laboratories will be found to have a conductivity of from three to five units. After storage in soft glass bottles, the value is usually much higher, and conductivities of thirty and over in samples obtained from pharmacists do not necessarily indicate inferior methods of preparation. A value of six should be regarded as the maximum for freshly-prepared distilled water, and if higher values are obtained, the still should be carefully examined for leakages.

CHLORINATION*

By Charles A. Jennings, Assoc.M.Am.Soc.C.E.
Formerly Sanitary Engineer, Union Stock Yards, Chicago

LESS than ten years ago hypochlorite of lime was used for the first time on a large scale for the disinfection of a water supply. Previous to that it had been used in large quantities to prevent the spread of typhoid fever from polluted water supplies, but no attempt had been made to so treat a polluted water that disease-producing organisms would be eliminated and yet the water would remain unchanged in taste and odor.

In these ten years, the use of chlorine compounds in sanitary science has grown tremendously. As would be expected, because of such a rapid growth, the use of these substances has come into bad repute in some instances. Sometimes this has been due to the fact that over-zealous people expected more of the treatment than could be accomplished, and sometimes it has been because water companies or departments attempted to accomplish with chlorine compounds, work which called for clarification in conjunction with disinfection. Things have adjusted themselves very satisfactorily by this time and filtration has its place, decolorization its place, iron removal its place, chlorination its place, and so on. Some problems require for solution a combination of several methods of purification.

It was in 1908 that the epoch-making work was done at the Bubbly Creek filtration plant at the Chicago Union Stock Yards by Geo. A. Johnson, using hypochlorite of lime, in conjunction with a rapid sand filtration plant, to make potable a grossly polluted water. Previous to this it had been considered sufficient to remove 97% of the bacteria by purification processes.

Since that time, however, filtration plants in nearly every instance use chlorine compounds as a finishing treatment. By the process of filtration, bacteria are removed mechanically. An average of 97% to 98% of the total bacteria can be removed by this process. Chlorine compounds are used as a finishing treatment because they seemingly have a selective action for the organisms that cause disease. The quantities required are very small. Every new filtration plant that is modern will be found to be equipped with a liquid chlorine apparatus for sterilizing the filtered water.

Whereas hypochlorite of lime was formerly used entirely for the disinfection of water and sewage, now it has been almost entirely replaced by liquid chlorine treatment. The reasons for this are many. Hypochlorite of lime, or "hypo," is a loose compound of lime and chlorine gas; in other words, the lime serves as a carrier for the chlorine gas. Moisture and carbonic acid in the air cause this loose compound to deteriorate by giving off chlorine. Shipment is made in wood and sheet iron drums, which

*Paper read at annual convention of the Southwestern Waterworks Association, April, 1918.

are likely to disintegrate. The strength of the hypo decreases rapidly upon exposure to the air. There is considerable loss to the material by being weighed out and being made up into a solution, and there is a great deal of undesirable nuisance connected with this operation. Accurate readings must be made of the amount of solution being applied. Orifices and solution feed lines clog up with undissolved material in the solution.

Advantages of Liquid Chlorine

Liquid chlorine, or compressed chlorine gas, is shipped in steel cylinders holding 100 or 150 lbs. each. These are similar in appearance and construction to ammonia, oxygen and carbonic acid cylinders. At room temperature the pressure on a full cylinder of chlorine is about 90 lbs. Being under pressure, there is no loss in the strength of the substance. In order to liquefy the gas, it is necessary to rid it of its impurities and so it will average over 99.8% pure chlorine as used from the cylinders. In the use of liquid chlorine for the disinfection of water and sewage it has been found that the ratio between the amount of hypo to the amount of chlorine to accomplish similar results is about 6:1, with a minimum of 3:1 and a maximum of 10:1.

These ratios depend upon the strength of the hypochlorite in the solid form, upon the care with which a solution is made of the hypo in the water and upon the care with which the solution is applied to the water. The ease of operation, especially the direct reading of the amount of sterilizing agent being used, lends itself to more accurate control and more consistent results than could be obtained by the use of hypochlorite. Tastes and odors are seldom met with in supplies treated with liquid chlorine. Milwaukee, Wis., effected a saving of $2,200 in one year on labor alone by the use of liquid chlorine instead of hypochlorite. An appreciable saving was effected also in the chemicals used in favor of liquid chlorine. Minneapolis, Minn., saved $1,800 the first year of operation with liquid chlorine instead of hypochlorite, all of which saving was in the cost of the chemicals. In addition to this there was a saving in labor. The average cost of disinfection with liquid chlorine during 1917 was 37 cents per million gallons. In more than two years, there have been no complaints of tastes and odors resulting from this treatment.

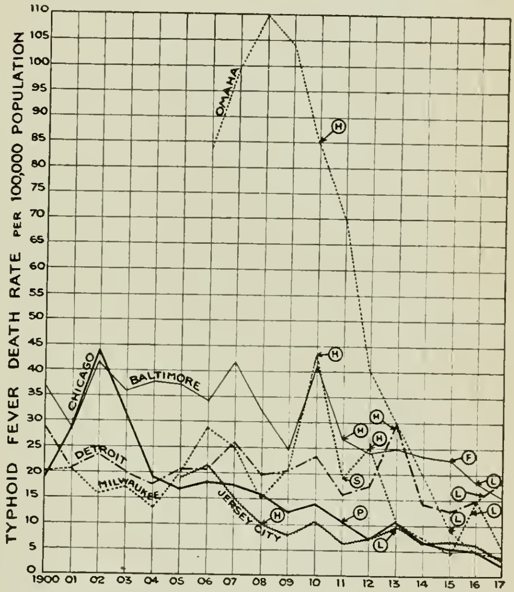
At the present time there are probably 1,200 cities in this country using chlorine compounds for the disinfection of water and sewage. Of these, possibly 300 are still using hypo and the others are using liquid chlorine.

Prejudice Has Almost Disappeared

The former prejudice against "doping the water supply" with a "foul-smelling chemical," has almost died out. This has come about through the successful treatment of water supplies, in most instances, without any production of odors or tastes, through the wonderful reduction in the typhoid fever death rates, and through the winning over of the health officers and other members of the medical profession to an understanding of what this treatment could and would accomplish.

There was a time, not so long ago, when as a result of a report submitted by a committee composed mostly of Washington members of the medical profession, the United States Congress decreed that no coagulating or other chemicals could be used in the purification of the water supply of Washington, D.C. To-day, the water supplies of most of the government cantonments, construction camps, ship-building yards, etc., are treated with liquid chlorine in addition to the fact that the soldiers and sailors are all vaccinated against typhoid fever; and in most of the camps, the water is obtained from underground sources. Practically half of the state boards of health of this country are supplied with a portable emergency chlorine control apparatus, weighing about 40 lbs., mounted in a carrying case, which is shipped out to municipalities in the event of a sudden typhoid fever epidemic or scare. Such measures make for expedition, increase the confidence of cities in the aims and assistance of state health departments, and help lower the typhoid fever death rates of cities by giving prompt and efficient control of emergency conditions.

Liquid chlorine is used in the disinfection of all types of water supplies; *viz.*, water obtained from rivers, lakes, impounded supplies, shallow and deep wells, filter galleries, filtration systems, etc. Mountain streams, impounded supplies and well water are no longer considered



H, Hypo Treatment Started; F, Filtration Started; S, Hypo Stopped; P, Partial Disinfection Started; L, Liquid Chlorine Treatment Started

safe because they are obtained from the mountains, storage reservoirs and the ground. There are too many contaminating influences to be considered. The Chicago Bureau of Public Efficiency, in its report on the waterworks of Chicago, states that "a water supply contaminated on four or five days in a year, may result in serious epidemics."

Many cities have learned that liquid chlorine is a safe, cheap and reliable form of health insurance. The manager or superintendent of a water plant who uses liquid chlorine treatment does not have to lie awake at night fearful of the quality of his water supply.

The city of South Bend, Indiana, obtains its water from deep wells. The U.S. Public Health Service analyzed the water during the summer of 1917 and found B. coli present. Disinfection was ordered to be installed at once. This was done. It was found that the water coming from the wells was pure. The water being pumped from the storage reservoir was polluted. The chlorine was applied to the suction of the high-duty

pumps beyond the last possible point of contamination. Then steps were taken to remedy the condition causing the contamination to the reservoir.

A small city in Michigan derived its supply from wells. The State Board of Health discovered a cross-connection with a pipe leading from the river.

Chlorination was ordered to be installed at such a point that whether the cross-connection was open or not, all of the water would be treated with liquid chlorine.

Many cities having supplies from underground sources have conditions similar to those at South Bend, and frequently have epidemics of intestinal disorders in their cities. Because a water comes from a deep well is no criterion of its purity as it is supplied to the consumer, if proper precautions are not taken to prevent its contamination. Frequent analyses of all water supplies should be made. Given the proper conditions, a spring, deep well or other originally pure water can and will become contaminated as quickly as a surface water.

Liquid Chlorine in Hospital Camps

Liquid chlorine is now being used in many of the government hospital camps in the United States and abroad, for the preparation of the Carrel-Dakin solution, which is used in the treatment of wounds.

A recent use for liquid chlorine has come to the notice of the writer. An Illinois city having a deep-well supply that has an iron content of two parts per million, aerates and filters the water to remove the iron. Recently considerable difficulty has been experienced due to the growth of crenothrix in the storage reservoir and distributing mains. Liquid chlorine is being used for killing this organism, because copper sulphate treatment has been unsuccessful.

Tanneries discharge liquid wastes carrying the anthrax organism. This germ is what is known as a spore former, and it is very difficult to kill it. The U.S. Bureau of Animal Industry has recently issued regulations governing the treatment of these wastes with liquid chlorine.

Packing houses discharge liquid wastes that have very disagreeable odors. Recent experiments on a large scale in a packing house indicate that it is possible so to treat these wastes with liquid chlorine that the odors will be rendered practically unnoticeable.

By means of liquid chlorine treatment, many other kinds of trade wastes can be successfully disinfected and the odor reduced to a point where no nuisance will be committed.

Swimming Pools Dangerous

Little thought has been given by the layman to the gross contamination that results from the use of the average swimming pool. The shower bath that is made a preliminary to the swim at most pools is usually a sham and does little good. A pool is certain to become highly polluted as a result of bathers using it. The modern method of keeping a swimming pool in a sanitary condition is to pump from the pool water at a rate sufficient to empty the pool in 18 to 24 hours. This water is forced through a pressure filter to clarify it and then it is sterilized with liquid chlorine and returned to the pool. In this manner a definite amount of polluted water is withdrawn from the pool and the same quantity of pure water returned to the pool continuously. No heating of the water is necessary in this purification process, as the water remains at the temperature of the pool.

Liquid chlorine is used as an adjunct to various methods of sewage treatment. The city of Cleveland, Ohio, is to install fine screens to clarify the city sewage and these screens will be followed by liquid chlorine disinfection. At many of the government camps, the sewage is sterilized by liquid chlorine, following treatment by septic tanks, filters and other systems. The amount of chlorine required is much greater than in the case of water purification, and varies from 40 to 90 lbs. per million gallons, depending upon the character of the sewage and the degree of purification desired.

As an example of what can be accomplished by chlorination of the water supply, the case of the city of Chicago offers excellent proof. Previous to 1900, all of the sewage of the city found its way into Lake Michigan, from which the water supply is taken. In 1900 the Chicago Drainage Canal was opened, which served as a method of disposing of the greater portion of the sewage. The Chicago River, formerly flowing into the lake, was reversed and was made to flow in the opposite direction, carrying with it the city sewage and a definite quantity of lake water for dilution purposes. As time went on, more and more sewage was diverted from the lake, and control was exercised over the dumping of dredgings in the lake, discharge of lake boat toilets in the vicinity of the water intake cribs, and other similar sanitary measures. The curve showing the typhoid fever death rate of Chicago is remarkable, because it shows what the above-mentioned measures accomplished, and it demonstrates what partial disinfection and what entire disinfection of the water supply will accomplish. Chlorine disinfection was in use at some of the pumping stations during the period 1911-1916, but during 1917 all of the water pumped by the nine stations was chlorinated. The drop in the typhoid fever death rate from 5.2 to 1.7 is wonderful. During 1917 only one sample of water out of 1,779 samples collected for analysis, or .06%, showed the presence of B.coli. in 1 c.c. B. coli was present in 5.4% of the 10 c.c. portions tested. In 1916 there were 135 deaths from typhoid fever, and in 1917 only 43.

Baltimore's Experience

Baltimore's water supply is derived from lakes. Previous to the use of chlorination, the average typhoid fever death rate for the period 1907-1910, inclusive, was 35.38. Hypochlorite treatment was begun in June, 1911. For the years 1912-1915, inclusive, the rate was 23.13 or a reduction of 34.6%. In September, 1915, a filtration plant was put into service and a further drop resulted in the typhoid fever death rate. Liquid chlorine was substituted in 1916 for hypochlorite of lime.

Jersey City was one of the first cities to adopt chlorination of the water supply, beginning the treatment in September, 1908. The average rate for the years 1900-1907, inclusive, was 18.7. For the period 1909-1917, inclusive, the average rate was only 7.3, or a reduction of 60%—truly a remarkable showing for water disinfection. The change from hypochlorite to liquid chlorine was made in February, 1913.

The curve shows typhoid fever death rates for Detroit from 1900 through 1917, but only the four-year period 1909-1912 was considered in comparing the average rates before and after chlorination, in order to have the time periods comparable.

Hypochlorite treatment was begun in March, 1913, and the change to liquid chlorine was made three years later, in March, 1916. The average rate before chlorination was 19.25, and after chlorination 15.05, per 100,000, —a reduction of 21.8%.

How Waukegan Saved Lives

Waukegan, Illinois, is one of the many cities drawing its water supply from the Great Lakes which were forced to install water disinfection because of the large amount of

typhoid fever. The treatment was begun in April, 1912. Data are available only for the period from 1911 to the present time. In 1911 there were fourteen deaths from typhoid fever, and in 1912 there were twenty. The next year there were only two deaths, then for two years there were no deaths, and then three and six respectively for the two following years. In other words, for the entire period of five years since water disinfection was begun, there have been only eleven deaths from typhoid fever. The water supply at Waukegan should be filtered, because it usually carries considerable organic matter and turbidity. In this city the disinfection process has had exceptionally careful and conscientious supervision.

The Milwaukee curve shows an appreciable reduction in the typhoid rate after chlorination was practiced regularly. Hypochlorite was used June 21st to December 12th, 1910, not at all during 1911, February 2nd to March 18th, 1912, and then continuously after April 12th, 1912, until May, 1915, when liquid chlorine was substituted for hypochlorite and has been used continuously since that time. The average for the five-year period while disinfection was not in use (1906, 1907, 1908, 1909 and 1911) was 21.8. For the period 1913-1917, inclusive, the rate dropped to an average of 8.9, or a reduction of 59%.

Statistics Prove Chlorine's Efficiency

The water supply of Omaha is obtained from the Missouri River, which name is almost synonymous with "mud," and is coagulated and settled in large basins. In 1910 hypochlorite treatment was installed. For the period 1906-1909, inclusive, the typhoid fever rate was 99 per 100,000. For the period 1911-1917, inclusive, the rate was 25.4, a reduction of 74.3%, which is truly a remarkable accomplishment. The change to liquid chlorine was made in 1915. The death rate has steadily and consistently dropped since 1910, and for both 1916 and 1917 was below 5 per 100,000.

There is no doubt but that the use of liquid chlorine will continue to grow. The only danger is from over zealous sanitarians recommending its application in cases where it is not called for or in cases where it should be used in conjunction with some other process. As with all purifying agents, it has its limitations. Within its sphere of usage, it has demonstrated its reliability and simplicity, and its efficiency is proven by the above-mentioned typhoid fever statistics.

CANADIAN RAILWAYS AND CANALS

According to the annual report of the Department of Railways and Canals for the year ended March 31st, 1917, the total expenditure of the Dominion government for railways and canals was $48,226,082.40, of which just about $6,000,000 was for canals. The revenue for the year was $24,001,181.75, only about $500,000 of which came from canals. The total expenditure on railways and canals and revenue from them, up to March 31st, 1917, is as follows:—

Expenditure on railways	$734,998,814.43
Expenditure on canals	164,140,734.44
Expenditure common to both	1,457,384.31
Revenue from railways	248,395,298.47
Revenue from canals	16,665,271.32

The railway expenditure for the year ended March 31st, 1917, included $14,737,326.70 charged to capital account. This consisted of expenditure on the Quebec bridge, the Intercolonial Railway, the National Transcontinental, the Prince Edward Island Railway, the Hudson's Bay Railway, and other items. The expenditure on the Intercolonial on revenue account was over $15,000,000, on the Prince Edward Island over $800,000 and on the National Transcontinental almost $8,000,000.

EFFECT OF WATER IN CONCRETE

DOES the strength of concrete for given materials, made up and tested in a similar manner, depend upon nothing except the relation between the amounts of water and cement in the mix? Duff A. Abrams, professor in charge of the structural materials laboratory of the Lewis Institute, Chicago, claims that it does, so long as a plastic mix is secured. In an article written for "Engineering News-Record," of New York City, Prof. Abrams indicates that the aggregate plays no part in the strength of the concrete except insofar as its properties affect the quantity of water required. Commenting upon Prof. Abrams' article, the "Engineering News-Record" says editorially:—

"Entirely Without Precedent," Says Editor

"The article by Prof. Abrams on the basic principle of concrete mixes is noteworthy for the consistency of its data and the simplicity of its indications. The studies which have been carried out in the structural materials laboratory of Lewis Institute are entirely without precedent, bringing out clearly the fact that former studies of this kind have failed to reveal the elemental principles of concrete proportioning. Past failures can be traced to the circumstance that but little systematic effort was made to analyze the factors which affect the strength and other properties of this material. . . . These investigations also lead to many important conclusions regarding the testing of cement. For instance, it is Professor Abrams' belief that the whole scheme of cement testing should be radically modified. The data in the article suggest that if strength tests of cement were made on neat specimens of such a consistency that the water content were the same as that used in ordinary concrete mixes, a strength would be obtained which would be an exact indication of the strength of the concrete itself—clearly intimating that the testing of cement in connection with sand or aggregates tends only to complicate the problem while not serving any useful purpose. This supposition has been remarkably borne out in the experiments which are being carried on. Professor Abrams has found that neat cement mixed with about twice the amount of water indicated by the test for normal consistency exhibits, in compression, about the same strength as is shown by a 1 : 2 : 4 concrete specimen in which the relative quantity of water is about the same. Since purely physical facts are found inevitably by systematic study, it is unfortunate that there are not a greater number of laboratories devoting their attention to the many problems, so far indeterminate, with which the engineer has to deal. The example of the Portland Cement Association in bearing so great a part of the cost of Professor Abrams' work is one that should be followed more frequently."

The article to which the above-quoted editorial refers, is reprinted here in full on account of the apparently revolutionary results obtained:—

Water is Essential Element of Mix

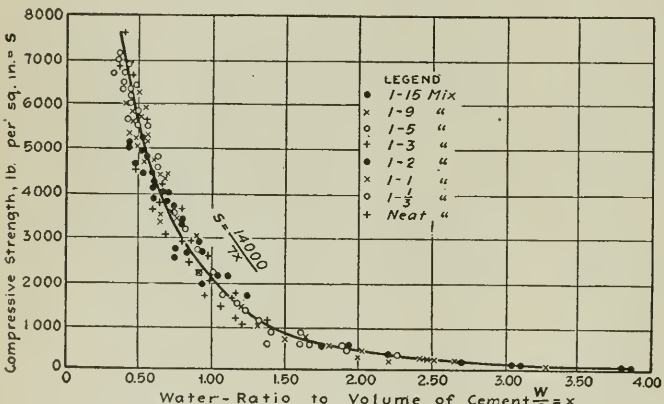
Concrete, it is commonly stated, is composed of a mixture of cement, sand and pebbles or crushed stone. This conception of concrete overlooks one essential element of the mixture—water. An exact statement of the ingredients of concrete would be: Cement, aggregate and water. The last-named material has not yet received proper consideration in tests of concrete or in specifications for concrete work.

Early users of concrete centered their entire attention on the quality of the cement, and practically disregarded

the characteristics of the other ingredients. During the past dozen years some attention has been given to the importance of the aggregate, but it is only recently that we have learned that the water also requires consideration.

Full Significance of Water Not Realized

A great deal has been said and written recently concerning the effect of water on the strength and other properties of concrete, but the full significance of this ingredient has not heretofore been pointed out. A discussion which appeared in the April, 1917, issue of the Concrete Highway Magazine gave a brief review of results of some of the experimental work carried out along this line at the Structural Materials Research Laboratory, Lewis Institute, Chicago. The relation between the water content and the compressive strength of the concrete for a wide range of consistencies was there pointed out and emphasis was placed on the injurious effect of too much water. Tests made in studies of the effect of size and grading of aggregates have shown that the only reason concrete of higher strength and durability can be produced from well-graded aggregate as compared with a poorly graded aggregate is that the former can be mixed with less water. If this is not done no advantage is gained from using a well-graded aggregate. The following discussion shows that a similar conclusion can now be stated with reference to a rich concrete mix as compared with a lean one.



Lean and Rich Mixtures Show Striking Similarity in Strength Variation for Differing Water Contents

While the injurious effects of too much water in concrete is apparent, tests made in this laboratory show that the truly fundamental rolê played by water in concrete mixtures has been entirely overlooked in previous discussions of the subject. The relation referred to above is brought out by a series of compression tests of about sixteen hundred 6 x 12-in. concrete cylinders made up as follows:—

Mix Cement-Aggregate.	Ranges of Sizes of Aggregates.	Consistency.
1:15		
1:9	0-14-mesh sieve	
1:5	0- 4-mesh sieve	Different consistencies for each mix and aggregate.
1:3	0-¾-in.	
1:2	0-1½-in.	
1:1	0-2-in.	
1:⅓		
Neat		

The mixes used covered a wide range, as did also the grading of aggregate and consistency. The aggregates consisted of two sizes of sand and mixtures of sand and pebbles graded to the sizes shown. The mix is expressed in terms of volumes of dry cement and aggregate, regardless of grading; *i.e.*, a 1:5 mix is made up of 1 cu. ft. cement (1 sack) and 5 cu. ft. of aggregate as used, whether a sand or a coarse concrete mixture.

Many Different Combinations Studied

This series gives valuable information on the effect of changing the quantity of cement, the size of the aggregate and the quantity of water. The effect of many different combinations of these variables can be studied. One set of relations gives the effect of amount of cement using aggregates of different size and grading; another set of relations gives the effect of different quantities of water, varying both mix and size of aggregate. In all respects the tests bear out the indications of earlier and later series, and reveal the true relation between the strength and the proportions of the constituent materials in concrete. The figure shows the relation between the compressive strength and the water content for the 28-day tests. The water content of the concrete has been expressed as a ratio of the volume of cement, considering that the cement weighs 94 lbs. per cubic foot. Distinguishing marks are used for each mix, but no distinction is made between aggregates of different size or different consistencies.

When the compressive strength is plotted against the water in this way, a smooth curve is obtained, due to the overlapping of the points for different mixes. Values from dry concretes have been omitted. If these were used we should obtain a series of curves dropping downward and to the left from the curve shown. It is seen at once that the size and grading of the aggregate and the quantity of cement are no longer of any importance except in so far as these factors influence the quantity of water required to produce a workable mix. This gives us an entirely new conception of the function of the constituent materials entering into a concrete mix and is the most basic principle which has been discovered in our studies of concrete.

The equation of the curve is of the form,

$$S = A/B^x \qquad (1)$$

where S is the compressive strength of concrete and x is the ratio of the volume of water to the volume of cement in the batch, A and B are constants whose values depend on the quality of the cement used, the age of the concrete, and curing conditions.

Law of the Strength of Concrete

This equation expresses the law of strength of concrete so far as the proportions of materials are concerned. It is seen that for given concrete materials the strength depends on one factor only—the ratio of water to cement. Equations which have been proposed for this purpose contain terms which take into account such factors as quantity of cement, proportions of fine and coarse aggregate, voids in aggregate; but they have uniformly omitted the only item which is of any importance, the water.

The relation given above holds so long as the concrete is not too dry for maximum strength and the aggregate

not too coarse for a given quantity of cement; in other words, so long as we have a workable mix.

For the conditions of these tests, equation (1) becomes,

$$S = 14{,}000/7^x \qquad (2)$$

Other tests made in this laboratory have shown that the character of the aggregate makes little difference if it is clean and not structurally deficient. The absorption of the aggregate must be taken into account if comparison is being made of different aggregates.

In certain instances a 1:9 mix is as strong as a 1:2 mix, depending only on the water content. The strength of the concrete responds to changes in water, regardless of the reason for these changes.

It should not be concluded that these tests indicate that lean mixes can be substituted for richer ones without limit. We are always limited by the necessity of using sufficient water to secure a workable mix. So in the case of the grading of aggregates. The workability of the mix will in all cases dictate the minimum quantity of water that can be used. The importance of the workability factor in concrete is therefore brought out in its true relation.

The reason a rich mix gives higher strength than a lean one is that a workable concrete can be produced by a quantity of water which gives a lower ratio of water to cement. If an excess of water is used we are simply wasting cement. Rich mixes and coarse, well-graded aggregates are necessary as ever, but we now know just how these factors affect the strength of the concrete.

Curve May Be Used Practically

Practical use may be made of the curve in estimating the relative strength of concretes in which the water content is different for any reason. For example, a concrete mixed with 7.5 gallons of water (1 cu. ft.) to one sack of cement (allowance being made for absorption of aggregate) gave a strength in this series of 2,100 lbs. per square inch ($x = 1.00$). For $x = 0.80$ (6 gal. of water per sack of cement), we have 3,000 lbs. per square inch; for $x = 0.75$ (5.6 gal.) 3,300 lbs. per square inch. Concrete in a 1:4 mix (same as usual, 1:2:3 mix with a coarse sand) should be mixed with $5\frac{1}{2}$ to 6 gallons of water per sack of cement.

The importance of any method of mixing, handling, placing and finishing concrete which will enable the work to be done with a minimum of water is at once apparent. It now seems that practically all faulty concrete work can be traced to the use of too much water.

These studies lead to many important conclusions with reference to such topics as tests of cement, tests of concrete containing admixtures, etc. Tests of cement from this viewpoint have been under way several weeks.

R. S. Crain, a contractor of Ottawa, has purchased the brick and terra cotta works at Beamsville, which has been closed for the past three years.

At the annual meeting of the Ontario section of the American Society of Mechanical Engineers, held in Toronto, May 27th, Prof. R. W. Angus, of the University of Toronto, was elected chairman for the ensuing year. Chester B. Hamilton, Jr., of the Hamilton Gear and Machine Co., Toronto, was re-elected as secretary. The members of the executive for the coming year are James Milne, of the Department of Works, Toronto; J. H. Billings, of the University of Toronto; and G. V. Ahara, of the Canadian Fairbanks-Morse Co., Toronto.

WATER RESOURCES OF BRITISH COLUMBIA*

By William Young
Controller of Water Rights, British Columbia

SPEAKING of the water resources of British Columbia, there is no territory of the same size on the continent of America so favorably situated in this respect. A glance at the map immediately reveals the immense stretches of water north and south. The value of this resource is not fully appreciated. We hear much of our wealth in forest and mines, but little of water, yet there is no resource of greater value to a country. The welfare of all our cities and towns depends upon a wholesome supply of domestic water; town and city lighting and electric railway systems depend upon this resource, also our mining industries, our pulp mills and the bulk of the arable land in the southern part of the province. On this resource depends our great salmon fishery industry, and speaking of inland transportation by water, in the southern part of the province a thousand miles have been navigated by vessels of 100 feet and upwards in length, while in the north there are large stretches of navigable waters the extent of which we are not as yet fully informed on. So, while it is not the intention to refer to more than the purposes of irrigation and water power, even such is too large a subject to fully cover in the space allotted to me and in the circumstances I can only direct your attention to some of the main features.

Irrigation

The extent to which water is used for irrigation purposes is perhaps not generally appreciated. With the exception of the lower mainland and the small areas along the coast, practically every district south of the 52nd parallel is dependent upon irrigation. According to the statistics of the Agricultural Department, slightly over 300,000 acres of land are given as being under cultivation throughout the province. Of these, 100,000 are cultivated under irrigation conditions. Now, when it is realized that by means of irrigation three blades of grass can be made to grow where one grows under dry farming conditions, the production from these 100,000 acres of land is one-third greater than that from the other 200,000. This land, in acreages varying from a few to some thousands, is situated in the several valleys along the banks of the rivers, wherever there are creeks. Although I have given the acreages cultivated under irrigation, there still remains 400,000 acres for which water rights have been acquired and which in time will be developed. The fruit industry of British Columbia has been developed entirely by irrigation and where 25 years ago, even less, districts, particularly in the Okanagan, were unknown as fruit-producing, to-day they stand in the same relation to Western Canada as the Niagara Peninsula does to Manitoba, Ontario and Quebec, and Annapolis Valley to the Maritime Provinces; so a great industry has been built up almost entirely dependent upon irrigation. When I first came into close touch with irrigationists of these districts, the thing that amazed me was the tons of fruit going to waste and the absence of canneries. I do not propose to make any statement as to the reason, but at that time you could go into any general store in the interior and find its shelves laden with canned goods shipped in from a distance of 2,500 miles. The failure of the first two canneries in the Okanagan, the reorganization of one and the fight it had to overcome the throttling methods of competition, is another question.

*Abstracted from address delivered before the British Columbia Manufacturers' Association.

Although some of you may be informed on this, I make mention of it to acquaint you with the fact that a great industry has not and may not yet be free from such influences.

Power Sites

Passing to the water power resources of the province. I have only noted a few of the power sites because as yet we have little, if any, knowledge of a great portion of the province in this respect. We do know, however, that in practically every district there is a water power of first magnitude located. Beginning with the East Kootenay, on Elk River, there is a power of upwards of 10,000 horse-awaiting development. Coming west in the vicinity of Nelson are the developments at Bonnington Falls by the West Kootenay Power Company and Nelson city. At this location the river may be developed at a number of places. As a direct result of the development of Bonnington Falls we have the cities of Trail and Grand Forks and their smelters. In the first-mentioned is to be found one of the largest on the continent and I am informed the only one turning out silver, gold, zinc, lead and copper and a number of by-products.

South, we have two small developments in the vicinity of Grand Forks, with great possibilities on the Pend d'Oreille River awaiting development. In the Railway Belt at Revelstoke the city has a small development and although there are many power possibilities here, there has, as yet, been no real investigation to determine to what extent they may be developed. In the Kamloops district there are a number of sites, Adams River, Barriere River and Myrtle Falls. Of these, the Barriere has been developed by the city of Kamloops and is now supplying power to that city and for irrigation purposes along the Thompson River, the latter use increasing from year to year. In the Lillooet district there is a great power at Bridge River which may be said to be strategic to that whole district. Coming to the coast north of Vancouver, there are many power possibilities, the important developments being Powell River, Ocean Falls and Swanson Bay. There are a great many other sites of varying magnitude, of which we have as yet little knowledge. It is most interesting in this district to note that the great lakes, which form the headwaters of the west branch of the Fraser River and the south branch of the Skeena, are at an elevation of approximately 2,700 feet and about 20 miles from tide water. We have little knowledge of the divide between these lakes and the tide water, but it is obvious that there are possibilities that are enormous. In the vicinity of Prince Rupert are to be found a large number of locations of varying size, from a few hundred horse-power up to 20,000 or thereabout. Travelling eastward from Prince Rupert along the line of the Grand Trunk Pacific, there are many locations of first magnitude, of which as yet we have few facts, and as to that portion of the province to the north of this railway, there are many sites which remain to be investigated and which in time may be made use of.

Developments Planned for Vancouver Island

On Vancouver Island a number of excellent sites are to be noted, the developed ones being Jordan River, Goldstream, Nanaimo, and the Puntledge, while the undeveloped ones of first magnitude are Stamp Falls, Campbell River and Nimpkish River. At Swanson Bay one of the pulp companies has plans under way for a paper industry similar to the Powell River, Ocean Falls and Swanson Bay, but not of the magnitude of the two former in that the power available is not quite so great. Of the possibilities on the island, too much cannot be said of Campbell River. It is strategic to the whole island and, according to various opinions, ranges all the way from 100 to 150,000 horse-power or more, inasmuch as there are wonderful storage possibilities behind it.

Hundreds of Small Sites

Leaving Vancouver out of consideration for the present, I have briefly outlined to you the general location of power sites throughout the province, making no mention of the hundreds of small ones of which we have little knowledge, but which may be developed in a similar way to some 50 or 60 in and throughout the Kootenays—sites that produce from 50 to 200 horse-power and which are used for lighting and in the operation of mines and concentrators. It will be obvious to many of you that powers of such magnitude are of inestimable value when the time comes that here and there throughout the province industries spring up which can be operated by power from such sites.

SHIPBUILDING AT HALIFAX

SHIPBUILDING on an extensive scale at Halifax, N.S., is foreshadowed in a formal announcement by Hon. C. C. Ballantyne, Minister of Marine and Fisheries. Private interests have bought the former site of the Acadia Sugar Refinery, adjoining the drydock, and three shipbuilding berths will be erected. These berths will be large enough to accommodate boats of approximately 10,000 tons, and it is expected that ships will be launched within fifteen months. The enterprise is known as Halifax Shipbuilders, Limited, the prime movers being James Carruthers, J. W. Norcross and R. M. Wolvin. They contemplate an outlay of $3,000,000 or $4,000,000 on structures and equipment.

Mr. Ballantyne announced recently that he was negotiating for the erection of a modern shipbuilding plant somewhere on the Atlantic coast. It was pointed out editorially in *The Canadian Engineer* for May 9th, that Halifax is the port in Canada which needs shipbuilding the most and which nature built most ideally for the purpose. There is no other way in which a steady, plentiful and economical supply of labor can be assured for ship-repairing; and ship-repairing is essential at Halifax. Workmen can be transferred at a moment's notice from ship-building to ship-repairing jobs.

Big Help to Naval Authorities

Mr. Ballantyne says that the only assistance that the government is giving to the enterprise is the placing of a limited number of contracts at fixed prices for the construction of modern steel freighters of about 10,000 tons capacity. The government had not even indicated to the promoters any particular site upon which the yard should be established.

It is expected that the industry will employ between 3,000 and 4,000 men. The city council of Halifax has granted tax exemption to the company.

The construction of this shipbuilding plant will be a matter of great satisfaction to the naval authorities of Canada and Great Britain, who have for some time past keenly realized the advantage to their work which would accrue from the location of a large shipbuilding plant at Halifax. This plant will also be very useful after the war in providing repair facilities for modern marine machinery. There has been to date a great lack of such repair facilities at Halifax, with consequent detriment to the progress of that port.

ROTARY SNOW PLOW

AUTOMOBILES and motor trucks, by their comparatively sudden increase in popularity, have made useless most of the old-time methods of snow-road making, particularly on suburban streets and country roads in localities of heavy precipitation.

The road surface which would bear a sled, often breaks beneath the automobile. To maintain a road properly for this new travel by the old methods is often prohibited by the cost, and sometimes made impossible by labor scarcity. These conditions have led to the development by the Canadian Fairbanks-Morse Co., Limited, of the Stadig rotary snow plow. Besides making roads, after particularly heavy snow falls this machine has shown a greater capacity in clearing sidewalks than a thousand men with shovels.

Drawn against a snow bank by a team of two or four horses, this plow scoops up the snow and throws it aside. The horses only move the machine, the power for scooping up and discharging the snow being furnished by an engine which is a part of the apparatus.

Tests made by the city of Outremont, P.Q., on one of these plows, yielded valuable snow-removal data. The following from the report of February 6th, 1918, by City Engineer J. Duchastel to the mayor and aldermen of Outremont, gives a clear summary of results on Cote St. Catherine Road:—

"Figuring the cost of gasoline, time of operator, corporation teams and helpers, as well as time of grader and single snow plow used in connection with this work, we find that the cost per lineal yard of street cleared (one side only) is 7.2c. This work covers a period of 23 hours, and a bank of snow 6,775 feet long, 10 feet wide and 1 ft. 9 ins. high was cleared in that time.

"As a parallel to this work, the cost of removing snow on the same date, on another section of Cote St. Catherine Road, under the same conditions, was kept, the snow being loaded by hand in sleighs and removed to a dump

Rotary Snow Plow at Work on Cote St. Catherine Road, Outremont, P.Q.

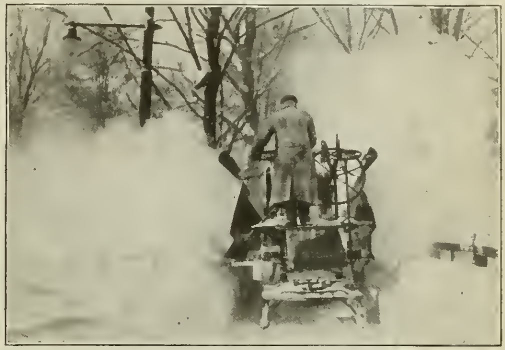
less than one-quarter of a mile away. The cost per lineal yard was 23.72c.; this work covers a period of 10 hours, and a bank of snow 950 ft. long, 10 ft. wide, and 1 ft. 9 ins. high was cleared in that time.

"As a check of these last figures, the cost of clearing Cote St. Catherine Road by this method was kept last year, and the figure per lineal yard of street (one side only) was, under practically the same circumstances, 27.4c."

In calculating these costs, 10% depreciation, 7% interest and a liberal amount for repairs were figured in addition to operating expenses. These data show that the road was cleared by the rotary snow plow at less than one-third the cost by hand.

Referring to the clearing of sidewalks, Mr. Duchastel's report says:—

"This machine was also used in opening up of sidewalks in sections of the city where drifts made them impassable. An accurate count was kept of this work, details of which I have on record in this office. From 11



Rear View of Rotary Snow Plow in Operation

to 12 miles of sidewalks per day have thus been cleared at the cost of $30.45 per day. It is difficult to arrive at the actual cost of this work by other methods, but I believe that I am not too optimistic in saying that a saving of 50% was made."

The common methods of snow-road making which were successful before the automobile became so universal, are the hand shovel, the "V" plow, the road grader and the snow roller. To these might be added the street railway company, when it happens to have a line along the road of immediate interest.

Where the snow is considerable, the first three methods require that it be taken away, because the banks would become so high after a few storms as to make continued clearings almost impossible.

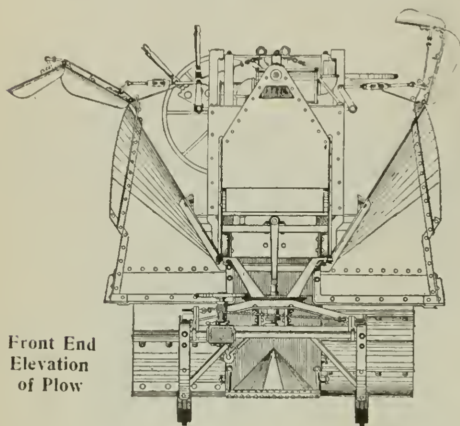
The snow roller is only satisfactory for sleigh roads and where the surface it leaves may be sprinkled, thus forming a heavy crust of ice; but the surface left by the roller, whether sprinkled or not, though satisfactory for sleighing, has not been sufficient to carry automobiles and heavy trucks. The rotary snow plow, says its inventor, does not necessitate the removal of the snow by human agency, because the plow throws the snow to a considerable distance, thereby distributing it over a large area or into the wind, which carries it away.

A four-bladed rotary cutter on each side of the machine, revolves on a horizontal shaft at 500 revolutions per minute, and scoops up the snow, discharging it from both sides of the machine. The snow may thus be thrown forty feet, being hurled clear for a distance of ten feet; or, if surroundings limit the distance to which it should be thrown, this may be controlled by moving the double dampers. The distance of projection may in this way be limited at will to any point from the extreme of forty feet to a discharge straight down.

The horses are not required to do very heavy work. The machine slides on runners; the front sled is high

enough to clear a 24-inch bank of snow without dragging. If desired, the machine may be set to an offset on the front and rear sleds, so that when cutting the bank away in widening the road, the horses travel on part of the road already cleared.

In one traverse the machine clears a space 5½ feet wide. The depth of cut and the slope of its surface may



Front End Elevation of Plow

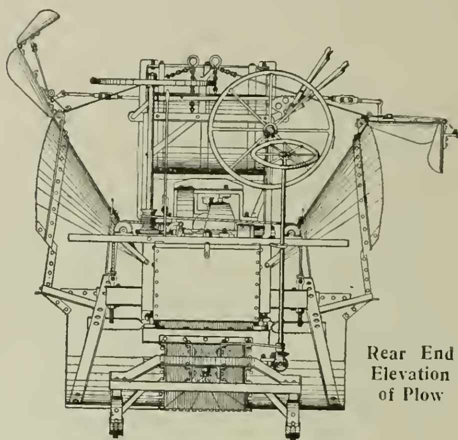
be regulated by moving the rotary cutters as the machine passes along. Thus the surface of the road can be made everywhere the same height. An uneven or tilted surface can be levelled; or a 22-inch comb, 1 inch to 4 inches high, can be left by centre plow adjustment. In two traverses (out and return) a road 11 feet wide can be cut, and this width can be increased by additional traverses, the snow being thrown beyond the part already cleared.

At the Good Roads Congress held this month in Hamilton, Ont., the following discussion arose concerning this new snow plow:—

Col. T. Hugh Boorman, of New York City: "I notice in the hall a picture of a rotary snow plow which has been used in Outremont. I came to Canada to see if there is any possible way, in these days of war, of economizing. I understand there is great shortage of labor, and any man who is saving an hour's time is doing his bit. I am sure we should be glad to hear if you could tell us whether there is any saving of labor by the use of the Stadig machine."

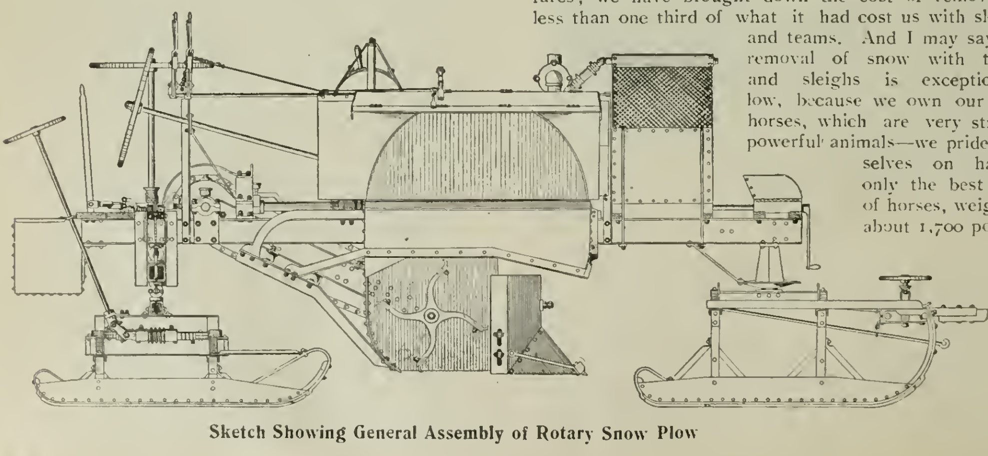
The president of the congress, Mr. Duchastel: "I will be very pleased to give you my experience with the machine. We have in the locality of which I am engineer, a machine built on the Stadig patent. While I admit that it is not a machine to be used in a city proper, it has done wonderful work in our suburban area. We have building regulations that are rather severe and our streets are rather wide. They vary between sixty-five and eighty feet, and we compel the citizens to build their houses anywhere from ten to thirty feet back from the street line. I bring this out simply to show you we have plenty of space on which to throw the snow.

"We have used this machine for one year. The machine picks up the snow with a rotary plow and pro-



Rear End Elevation of Plow

jects it to either side. Flanges direct the snow, and if the wind is high, a great quantity of this snow is blown away. I have had figures very closely calculated on the work performed by this machine, including the cost of operation, the cost of depreciation, and so forth. I have found that we have economized on our main thoroughfares; we have brought down the cost of removal to less than one third of what it had cost us with sleighs and teams. And I may say our removal of snow with teams and sleighs is exceptionally low, because we own our own horses, which are very strong, powerful animals—we pride ourselves on having only the best type of horses, weighing about 1,700 pounds



Sketch Showing General Assembly of Rotary Snow Plow

each—and our dumps are very close. Even then, with the low cost of dumping, we have cut down that cost to one-third.

"I strongly recommend that type of machine for open districts. On the rural roads, possibly, you could not get through drifts as large as those pointed out to us yesterday by Col. Sohier, with a machine of this kind, because you naturally can only get through the drift through which your horses will pull you through.

"We had four horses on this work, and in some exceptional conditions we might require six, but we have opened up as much as eleven or twelve miles of sidewalks, banked up on both sides, in one day. I think that is all I can say. As to the remarks of Mr. Drinkwater in connection with the snow roller, I agree entirely with him. It is very good to use a roller and a very practical way to maintain winter roads when you have to contend with sleighing alone, but it only hardens the surface or crust of the roadway, and when you have a slight thaw the roads get rutty in no time."

ABOLISH OPEN WELLS IN MUNICIPALITIES*

By W. C. Duncan, Columbus, Indiana

OURS is comparatively a new country—for within the memory of some yet living, where we meet to-day, the capital of our state, a city of 300,000 inhabitants, was once but a wilderness inhabited only by savage beasts and more savage men. The problem of the pioneer in life protection was a different one from ours to-day. Then he found it necessary, when he left his lonely cabin, to carry his rifle ever upon his shoulder, not knowing what moment he should meet the foe of civilized life, and it be necessary to grapple with him in a death struggle.

He had to depend upon himself for security of person and property. But as civilization advances and both people and property gather together, concentrating in cities, they find it convenient to put away the rifle, and all joining in a community effort, they employ a few officers and commit to them the protection of life and property while the others go about their labors in the day time, and lie down at night to rest in a measure of peace and security. The foe of life now is a more insidious one than the pioneer had to meet, but is just as relentless and as destructive to life. This foe comes with a congested population everywhere, in the form of disease germs.

These represent community diseases and must find a way into the human body through one of the avenues of air, food or water. The special subject assigned me on this program, "Why Private Wells in Municipalities Should be Abolished," I much prefer should read "Why Open Wells in Municipalities Should be Abolished." The word "private" is broad and sweeping and involves some rather innocent with guilty wells, for in many localities there are deep driven wells that do not offend so much as sources of water supply, while the open well is the dug well, which we hope to be able to show you is a natural draw for polluted surface water. Under my own personal observation, the open well in the city of Columbus in years gone by has been the source of serious prostration of families by typhoid fever. One instance in particular, where a whole family, one after another, through a long period, hovered between life and death, becoming a helpless charge on the community, costing the associated charities of our city more than $2,000. It was not until after the second family came down with the same disease from the same well, that this well was condemned and put out of commission. That the open, or excavated well is subjected to infection from surface drainage is now conceded. But does anyone know how far out from its mouth its suction will extend on the surface? Of course the answer to this will depend upon the character of the soil surrounding the well. We can get some idea by analagous reasoning. As an illustration, take the farmer's experience in draining his fields of surface water. He lays his tile, say, a 4-inch tile, two feet under ground, and he knows that thus laid it will drain out the surface water for one rod each way. He puts it down six inches deeper and it will drain two rods each way. And so on in an arithmetical progression—the deeper he lays this tile the farther out its drainage capacity will extend.

Apply these results to an open well 4 feet in diameter instead of 4 inches, and extended into the earth 20 feet instead of 2 feet, how far will it draw upon the surface water? One thing certain, it will draw a long way until filled up full of water, when the resisting pressure would be restored but the water circulation would still reach the infected sources. Now, as I said before, if this source of water supply is to be abolished, it should only be when an ample quantity of pure water is supplied in its place. The city of Columbus had this water problem for years, and thrashed it out through long and bitter experiences, and with many makeshifts, but I am happy to say that it settled down in a practical and effectual way when it built its present filtration plant, some six years ago. We have had it in use now long enough to see its advantages. We have had a distinct decrease in all water-borne diseases since it came into use. We lack something yet, along the line of a riddance of these open wells in our city. We have been trying for several years by a sanitary survey of the city to locate all of these with a view to putting them our of existence as soon as possible. Our city owns its water system and is furnishing pure water at the lowest rate of any city in our state. We are just now wrestling with the problem of how to increase the revenues of the water service to self-supporting principles. Our city, like many others, and like all should do, has gone to great expense in providing a pure water supply for its people.

That, as an investment for the public health and comfort, is worth all it costs the people. But the city, like any other prudent investor of capital, should see to it that all of the inhabitants of the city have a chance to get its benefits. For this only will measure up to the full benefits in health, convenience and comfort which this investment will bring to the people of the city. I will propose as a solution of the revenue question, not a raise in rates, but, instead, that every property owner, where a family shall reside, be required to put the city water privileges on the premises and in the residence, and all water rents be collectable from the property owner, and make their collection as certain as taxes are assured.

Having provided something better in pure water, we may abolish the open cesspool well and eliminate from the city typhoid fever and other diseases from polluted water. The water service, being properly handled, will have ample revenues for its support, at rates so reasonable that no one will have a just right to complain. Last, but not least, this will make it possible for the lawn in the home of the tenant as well as the landlord, to have its green sward throughout the summer and contribute to the beauty and refreshment of the whole city, and thus utilize all the benefits and blessings that may be available from the investment in pure water.

*Abstracted from address at the Eleventh Annual Meeting of the Indiana Sanitary and Water Supply Association.

CANADIAN SHIPBUILDING COSTS

By George W. Austen
Toronto, Ont.

At present there are in Canada fourteen shipyards in which steel freight vessels are being built. Most of them are still working on ships for the British government, ordered through the Imperial Munitions Board. But in Montreal, the Canadian Vickers Company has in hand two steel freight vessels for the Canadian government. One is 8,100 tons and the other 4,350 tons. In Vancouver a steel freighter for the government is being constructed. It is about 5,000 tons. At Collingwood, another of 3,550 tons is on the ways. These are the first vessels in the government's new State fleet programme, and the Montreal pair will, it is expected, be completed by autumn.

As the contracts of the Imperial Munitions Board are filled, new contracts will be placed by the Dominion government for vessels. It is expected that a tonnage of about 250,000 can be built in the fourteen yards, but it will be the end of this year before the majority of the yards will be free for building for the Dominion. The intention of the minister of marine and fisheries, with the approval of his colleagues, is to continue the building programme over a period of several years, devoting $30,000,000, $40,000,000 or $50,000,000 annually to the project. At the end of the period, Canada will have a large fleet of ocean freight vessels, a steel shipbuilding industry firmly established, and a seafaring population of much national worth. Unquestionably the programme will have a large effect upon our economic future, especially as after the war the trade competition on the seas will be the most acute ever experienced.

The Future of the Industry

It is rather curious, however, that no one seems to have questioned the costs of the programme, and their effect upon the future of the Canadian ship industry. Since the government provides the money, and everyone welcomes the building of steel ships, the secondary economic features of the programme do not appeal to the public. Yet, in the final analysis, the costs will have an important part in determining our maritime future. When normal conditions are re-established in ocean traffic, and cheap building and ship-manning exert their customary influence, we shall experience some of the ill-effects of the high costs incidental to the present ship emergency. We shall not be alone, of course, but it seems to be true that the steel ships we are building cost more than similar ships built in the United States and Britain. If the government undertakes the operation of the ships, the comparatively high initial cost will not handicap operating rates the same as would be the case in private ownership. Either the ships can be operated with no profit, or the excess cost written off.

Ocean transportation is a peculiar business, and a very difficult one. In it the shipowners of a free trade nation have an immense advantage, because of the lower costs of building and operation, and the extensiveness of the carrying that is done through large imports. But after the war, no nation is likely to have real free trade. The fiscal requirements of Britain, for instance, will force it to maintain heavy duties on many commodities, and the exclusion of German trade also may compel the British government to reconstruct the fiscal system. But experience before the war, during long decades of vicissitudes in the ocean-carrying business, has proven that, given a fair field, the British shipping companies will be undisputed masters of world traffic. They will have the big advantage of being able to build ships much more cheaply than overseas nations. The United States is calculating that its quantity production of steel ships will enable it to build them after the war as cheaply as Britain. But that is yet undemonstrated.

The president of the American Shipbuilding Company recently gave interesting figures, to show that construction costs in the United States are still excessive. The average daily wage for a nine-hour day in British, ten-hour day in Japanese, and eight-hour day in American yards is:—

	Britain.	Japan.	United States.
Skilled	$2.16 to $2.79	75 to 90c.	$5.80
Semi-skilled .	1.94	70	4.40
Unskilled ...	1.81	60	3.20

Since the cost of labor is about 50 per cent. in a steel ship, the difference in favor of Britain and Japan is startling. At present, steel ship plates are worth about $200 a ton in Japan, owing to shortage, compared with about $65 in the United States, thus equalizing the lower cost of labor. But if conditions return to normal with reasonable quickness after the war, it is certain that British and other European building costs will be far below American, in spite of the advantage the latter may have in the output of plates. Before the war, wages in British yards were about $15 for skilled labor and as low as $5 a week for unskilled. There can be no return to such low levels, but will not the proportionate cheapness of construction still remain heavily in favor of Britain?

Now, such conditions as these have a special meaning for Canada. Our costs of steel shipbuilding are higher than those in the United States. The average of wages for skilled labor in Canadian yards is from $3.75 to $5.50 a day, and from $2.75 to $3.75 for unskilled. This is somewhat lower than the American rate, but the difference is made up by higher costs of fittings and other material. The average price paid by the United States Emergency Fleet Corporation for steel ships is about $160 a ton, and, while figures of Canadian government contracts have not been published, it may be taken that they are probably close to $200 a ton. The gross cost estimated by the minister of marine and fisheries for a tonnage programme bears such a relation. Now, the contract of the government with the Dominion Iron and Steel Corporation for steel plates is based on a price of $4.25 per hundred pounds with ingots at about $24 a ton. The tonnage price for plates is, therefore, about $85, compared with the United States' price of about $65. On 250,000 tons of steel ships, there would be about 80,000 tons of plates and sections, and $20 a ton difference—it would be less, perhaps, because of freight and other charges—would make an excess charge of $1,600,000.

British Tonnage Still Much Cheaper

Some big transactions have occurred in British tonnage at prices approximating $80 a ton. This price has some relation to the replacement value after the war. The pre-war value of steel tonnage was from $40 to $50, and we interests will succeed in keeping costs at least down to may be sure that the skill and ability of British shipping the $80-a-ton level. If our Canadian government freighters cost nearly $200 a ton, what an excessive capital cost must be loaded on to them, compared with British ships, even those built now! Before the war, the British yards could turn out vessels from 25 to 50 per cent. cheaper than Canadian shipbuilders. This estimate is furnished by a Canadian shipbuilder. According to present relative costs, our ships must bear even a heavier

handicap. There is, of course, no alternative but to go on and build the ships, and, if necessary, write off the excess cost. Canada will need the ships. It needs a steel plate industry. It needs a ship-construction industry. The excess cost is as nothing compared with the waste of our railway era.

Germany built up a merchant marine of 5,000,000 tons by an elaborate system of subsidies and bounties. That merchant marine served Germany's trade interests so efficiently that the money devoted to subsidies was returned to the nation many times over. The experience of Canada is likely to be the same. Even if some of the fourteen shipyards now building steel vessels die off when the government contracts are finished, the remaining ones will have been so strengthened as to be able to compete on a fairly good basis for outside business. But it is probable that the expansion of Canadian business and traffic after the war will give them plenty of Canadian orders.

WATER TOWERS AND STANDPIPES*

FOR the most satisfactory and economical operation of any waterworks plant, an elevated reservoir is a necessity. It gives a reserve supply for fire protection, a high and uniform pressure on the mains and a minimum cost of pumping. If a natural elevation is available, a flat-bottom standpipe of large diameter and small height placed directly on the foundations is the most economical structure. When no elevation is available within a reasonable distance, a steel tower and tank is the proper substitute. In deciding whether a water-tower or standpipe should be used, account should be taken of the advantage of central location as well as the cost of laying additional pipe to reach the desired location.

While a standpipe is well adapted to meet certain conditions, one of small diameter and large height is never satisfactory. The first metal structures built for the storage of water were standpipes only a few feet in diameter and of sufficient height to give, when filled, the pressure required. Such a design is uneconomical, as the amount of serviceable water stored in such a tank is only a small portion of the total capacity. The water below an elevation of eighty feet is of little value for fire protection, and serves only to support the water above that point. Several times more water can be stored at an effective height for the same cost by a water-tower than by a standpipe. The tall cylinder of small diameter also has the great disadvantage of extreme variation in pressure between the time when it is full and empty. The water-tower and standpipe are not rivals, but each has its own distinct field of usefulness.

A tank should be of sufficient capacity to store the water used during the hours when the pumps are shut down and also leave at all times sufficient water in the tank to supply one or more fire streams for a reasonable period of time. Fifty gallons per inhabitant, with a liberal allowance for an increase of population, should be the minimum capacity provided, and no tank for municipal service should hold less than 30,000 gallons.

The height to the bottom of the tank should be at least eighty feet above the ground level at all points where the fire protection is needed. It is, however, often possible to locate the tank on a natural elevation so that the water-tower itself will not need to be eighty feet high.

*Abstracted from an article in April issue of "The Water Tower," house organ of the Chicago Bridge & Iron Co.

LETTER TO THE EDITOR

Gas From Waste Wood

Sir,—Replying to your letter of April 18th, the process of gas making from wood which we have been working upon here, has for its purpose the utilization of waste wood rather than the use of cord wood, making the charcoal residues of questionable value, since they are too fine for any of the ordinary uses of charcoal if the waste used is hogged wood. It is therefore difficult to make a comparison of costs by this process with the analysis of Riche costs given by Mr. Bacque in his recent article in your paper.

As a general proposition we have been able to get eight cubic feet of 480 B.t.u. gas from a pound of moderately resinous wood such as Douglas fir, this material being weighed with about 15% moisture. From this you can make your own estimate of the cost of 1,000 feet of gas of this quality, so far as costs of material alone are concerned, with any priced wood that you may assume. The comparison with the Riche costs will be unfavorable unless something can be secured as a credit by the sale of charcoal.

Mr. Bacque figures that with wood at $4.00 a ton, the net cost of materials would be 12.77 cents. If this same wood were to be made into 480 B.t.u. gas by our process, the cost, with no credit for charcoal, would be 25 cents per 1,000 feet, provided it gave the same yields of gas that Douglas fir will give. The gas would be better than Riche gas, however, by 160 B.t.u. per cubic foot, and allowing for this difference, the cost would still be greater for materials, since 320 B.t.u. in 480 B.t.u. gas costing 25 cents, would be nearly 17 cents.

I may say, however, that gas having the higher value in heat units is worth more for town distribution, unit for unit, than the other, since it is more desirable in domestic appliances and is cheaper to distribute. I suspect that operating and other costs in the process which we have may be less than in a Riche plant, and the further fact that waste wood or peat may be used is also in its favor.

I am very much interested to note from Mr. Bacque's article how satisfactory 320 B.t.u. gas was found to be for domestic use at Three Rivers, P.Q.

We are not quite ready as yet to make public the details concerning our process.

O. F. STAFFORD,
Department of Chemistry,
University of Oregon.

Eugene, Oregon, May 14th, 1918.

Manitoba last year co-operated with the municipalities of Portage-la-Prairie, Sifton, Wallace and others in the starting of road improvement schemes totalling an estimated expenditure of $459,000. This work was not all completed last year, much of it being left until after the war, but the more essential parts of the work are now being undertaken, such as the renewal of old bridges and culverts.

The Alberta government has refused the application of Edmonton for permission to discontinue the experimental sewage disposal stations. It is understood that the provincial government will not depart from their ruling which made it obligatory upon the city that sewage could only be discharged into the river on condition that preparations be made to ascertain the best method of sewage disposal, and that within a period the discharge into the river must stop. On this account the city has been spending annually quite a sum in testing the most recommended systems of sewage disposal. The late sewer maintenance superintendent, E. Evans, who had charge of the disposal plants, has already been given notice of dismissal by the city commissioners.

DEHYDRATED CONTRACTS*

By Albert P. Greensfelder
President, American Society of Engineering-Contractors

My appearance to-day before this convention to address you on this selected topic, is due to a recent conference with one of your members, E. E. Wall, water commissioner of St. Louis. We were part of a committee appointed by the St. Louis Association of Members of the American Society of Civil Engineers, to present the matter of a uniform engineering contract before the national board of directors of that body. The suggestion was made that your association would undoubtedly be interested in a similar document for general use of your members. On behalf of the American Society of Engineering-Contractors, therefore, it was felt incumbent upon me to present this subject for your earnest consideration, and to offer our co-operation.

Can You Write a Contract?

Contracts are not engineering products, but merely recipes for moral behavior. Waterworks were built by the ancients probably without such entangling alliances. The early Roman aqueducts were constructed without contractual relations, other than those of temperature. Even to-day, water free from impurities and injurious bacteria is possible without introduction of paper documents. Why, then, are there such impedimenta as contracts?

Contracts are often defined as bargains or agreements, enforceable by law. The law of nature is not implied, but the law of man. Contracts, therefore, have a human significance and it is that side which is the burden of my plea. You men who construct, operate and maintain the waterworks of this country are no small benefactors of mankind. Civilized anatomies demand water of quality, and civilizing industries require water in quantity.

Contracts *per se* affect neither of these, any more than do meters or pumping records. I do not believe there is a man in this room who, when qualifying his experience before his employer or examining board, was ever asked the question, Can you write a contract? If such test was a requirement of waterworks officials, I greatly fear for the constant supply at our faucets. Thus you will agree with me that contracts are dehydrated.

Dare Not Waste Efforts Now

If any one or several of us present, irrespective of our practical construction experience, were asked at this moment by your presiding officer to adjourn to an adjoining room and without books or references prepare and submit an equitable form of contract in five or even fifty hours, I suspect the results would be neither equitable, legal nor binding. Why, then; is the task so difficult or impossible of accomplishment? My answer is both yes and no. It is difficult because it is based on precedent and comparative experience, but it is not impossible, as has been amply proved in other fields of endeavor. By means of this simile you cannot help but grasp the purpose of my appeal.

The true purpose of any contract is to so clearly express one's intent that the meeting of minds of the two parties thereto is absolute. Much time, energy and money have been lost through neglect or inability to properly draft such instruments. In these days of conserved man-power and wealth, the necessity for proper contract forms is more essential than ever. We must not, dare not, waste efforts of any kind in these strenuous times. Our society, therefore, deems it both a prerogative and a duty to call upon its allies to function promptly and properly in this regard. Your members draft contracts which our members sign and execute. We are perfectly willing to abide by any form which your association may prepare, knowing full well that collectively your group has both the mind and purpose to present only that which would be equitable and fair.

Confusion and Delayed Undertakings

There can be no doubts even in the minds of your best professional contract-writing talent that this function can better be performed for the benefit of the profession as a whole, through preparation by your association as a body, than by the members individually as heretofore. There is no gainsaying the fact that occasional contracts have been and can again be, perhaps, better prepared by certain individuals equipped through brilliant minds, varied experience or unusual adaptability to perform such tasks. But even genius owes a duty to its profession which permits that genius to shine, and modern science recognizes its larger and broader duty to mankind and the public which supports it.

Much stigma has fallen upon technical and professional men and groups through improper or neglectful action in such public matters. Immature minds, youthful inexperience or slothful individuals have done great injury in the minds of their constituents towards splendid professions, such as yours, by their inadequacy or inaptitude in dealing with public funds which govern contracts.

Much confusion has resulted and many unnecessary legal tangles have delayed too many worthy undertakings fresh in the minds of my auditors to necessitate more than their mention now. Yet every time avoidable abstruse clauses or inequitable contracts cause complications and irritations in the public minds, just so many times do your members and your association gain public censure, deserved or not, depending on the point of view.

Suspicious of One-Sided Clauses

Is the public to blame for becoming impatient at excessive costs running unquestionably into hundreds of thousands of dollars annually, due to questionable terminology? Are contractors wholly to blame for being suspicious of the motives for insertion of special clauses and one-sided paragraphs? Are not bonding companies raising rates due to unnecessary penalty clauses and long-time guarantees? The banks charge more interest on retained percentages than city treasurers get, and payments for special materials delivered before incorporation in the work will make liens infrequent and prevent delays. Flexible methods of payments have been known to dispel disagreeable receiverships and arbitration clauses are merely human justice to eliminate interminable court proceedings. We are personally familiar with St. Louis and Louisville forms and acknowledge the unusual fairness and splendid abilities of both Mr. Wall and Mr. Wilson, and yet we hold no brief against possible betterments of even these documents. Again, we are in the midst of war, and war time equitable forms of bargain must be inserted in contracts if necessary work must proceed.

We might enlarge at length, but we are not here to-day to propose any favorite terms, to nurse pet hobbies for inclusion in your special contract form, or to propound

*Abstracted from address delivered before the annual convention of the American Water Works Association, May 15th, 1918.

any exclusive theorems for your elucidation. But we should like to have you feel that we are just as keenly alive to our obligations and responsibilities on our side as we know you are on yours. We have not been without reproach, and occasionally perhaps even worse, but we realize fully that through the influence of our members collected into a society, even as yours, our tendencies too are for improvement and sincere desire for co-operation on a continually rising plan.

Our society is composed of engineers on construction work and contractors in the engineering field. We uphold strict measures which make for quality of construction; we invite the proper placing of responsibility, and urge encouragement and recognition of construction service. We admit that we are human beings with human ambitions, but believe reliability is more worthy than cupidity. We remain in our profession because we enjoy its rewards, labors and sorrows better than in other fields of endeavor, and because we hope it is a genuine service to mankind. Help us along progressive lines and show us the light.

In conclusion, we seek no credit for this appeal, but we hope you will realize this civic opportunity and start this valuable work at once. If your board of directors upon request of the membership here assembled will appoint a standing committee on contract forms, to draft serviceable documents for your final action at your next convention, and such committee feels our society can assist it in any way, we beg to assure you we shall be glad to render service, endorse your results, and urge its use through our members and the public.

Following the address, the president of the American Water Works Association, Major Theo. A. Leisen, submitted Mr. Greensfelder's proposals to the meeting. They were warmly endorsed by those present.

FINDING LEAKS SAVES COAL

In the issue for May 7th, 1918, the Buffalo, N.Y., News says: "Water Commissioner George C. Andrews has reported to Commissioner Kreinheder, of the department of public works, that during April water pumpage was reduced 361,000,000 gallons, with a saving of 415 tons of coal, which means a saving of $1,850.

"The Pitometer experts have been at work searching for underground leaks which do not show on the surface of the streets and have found in Wyoming Avenue leaks which discharge 265,000 gallons of water every 24 hours into a sewer. Two broken curb cocks and a faulty hydrant which had been covered over in repaving, caused those leaks. They have been repaired."

Bacteriology seems to be a field, in which woman is destined for special instruction, says the "Woman Citizen," of New York City. A young lady of 21, Miss Margaret McCluer, has assumed the post of bacteriologist of Richmond, Virginia, releasing the former city bacteriologist for direct war service. There is need for about 100 women bacteriologists to take the place of men in the cantonment laboratories, the Surgeon General's Office of the United States Army announces. The service of the men is demanded for the hospital units which are going abroad and their places at the home cantonments are to be filled by women. Applications are arriving from all the camps, some asking for as many as nine women.

HYDRAULICALLY OPERATED VALVES*

High-pressure steam lines equipped with hydraulically operated valves, carry insurance against loss by accident that often makes the cost of the "premium"—the price of the valve—negligible. Here is a case in point, one out of many that might be mentioned:

In a large power plant "somewhere in the east," one of the big 35,000-kw. turbines was disabled, due to an accident to the blades. The accident caused a very uneven motion of the machine and a consequent hammer that broke off a number of the foundation bolts. The turbine was set on a high concrete foundation which also supported another turbine. Due to the uneven motion of the engine, the whole foundation structure was set in vibration and imminently subjected to most costly damage; but there was a hydraulically operated valve on the main steam header, and it was operated in time to avoid further damage.

There is not the slightest doubt that in this instance the saving was incomparably greater than the original cost of the valve and its installation.

These hydraulically operated valves as safety devices in power plants have been proven to be desirable, economical and reliable. As a general rule they are operated from the boiler feed headers, which in a power plant are very rarely released from pressure; consequently the power necessary for the operation of the valve, when it is used in emergency cases, always is at hand. This gives the hydraulically operated valve thus installed a distinct advantage over valves actuated by other power, especially electrical power generated by the prime mover that the valve is intended to protect. For, should an accident occur to the prime mover—as in the case cited—the power to operate the valve might be cut off before the operation was complete.

Careful engineering practice would indicate that without exception any valve intended to be operated from a distance, in a case of emergency, should have its power supplied from a source wholly independent of the power to be affected by the closing of the valve. The accepted manner of installing hydraulically operated valves in the steam lines of power plants makes these valves uncommonly desirable and reliable.

*From the "Valve World."

The Civic Light and Power Department, Edmonton, Alta., received three large contracts recently, to supply power to the University of Alberta, to the P. Burns Packing Company, and to the Pace Cannery of North Edmonton.

Theodore Morgan, of the firm of Henry Morgan & Company, Limited, department store, Montreal, stated last week in a newspaper interview that he feels certain that the present bad condition of Montreal's streets is causing $2,000,000 loss annually to the public through increased delivery costs, and extraordinary wear and tear on vehicles.

At a recent meeting of the Niagara Falls Board of Trade, a paper on carborundum was read by Francis R. Bowman. He described the discovery of the substance and its importance as a manufacture. The first plant of the Carborundum Company was located at Monongahela, Pa. During 1893, its first year of operation, the total output was 15,000 pounds. In 1895 it was decided to remove to Niagara Falls, on account of the possibilities of unlimited electric power to be secured there. A contract was accordingly made with the Niagara Falls Power Company for 1,000 horse-power. He pointed out how the confidence of the promoters has been justified, as the present plant covers 10 acres of floor space, is equipped to handle 25,000 horse-power, and upwards of 1,500,000 pounds of carborundum are made each month.

CONVENTION AT ATLANTIC CITY

PROVISIONAL programmes have been issued for the annual meetings of the American Society for Testing Materials and the American Concrete Institute. The latter organization will meet June 27th to 29th, while the former will meet June 25th to 28th, the headquarters for both meetings being the Hotel Traymore, Atlantic City, N.J.

On Thursday evening, June 27th, there will be a joint session of the two organizations. The programme for this session includes reports of committees on cement and reinforced concrete and treatment of concrete surfaces, and papers by J. C. Pearson on "Tests of Stucco"; W. A. Hull, "Tests of Concrete Columns"; D. A. Abrams, "Effect of Age on the Strength of Concrete"; L. N. Edwards, "Proportioning the Materials of Mortars and Concretes by Surface Areas of Aggregates."

The programme for the other sessions of the American Society for Testing Materials includes a large number of committee reports and papers on wrought iron, cast iron, steel, testing, industrial research, preservative coatings, non-ferrous metals, lubricants, cement, ceramics and road materials.

The programme for the other sessions of the American Concrete Institute include some committee reports and a number of papers on concrete properties and products, concrete design and tests, concrete roads and pavements, concrete structures and buildings and reinforced concrete barges and ships. Among the papers on this programme are the following:—

"Apparatus for Testing Under Uniform Load," by H. H. Scofield; "Plasticity and Temperature Deformations in Concrete," S. C. Hollister; "Concrete in Art Work," R. F. Havlik; "Problems in Concrete Surfaces," J. J. Earley; "Reinforced Concrete for Railway Purposes," Charles Gilman; "Moment Coefficients in Flat-Slab Design," W. K. Hatt; "Tests of Western Newspaper Building," A. N. Talbot and H. F. Gonnerman; "Theory and Test of Flat Slab with Ring Reinforcement," Edward Smulski; "Design of Concrete Chimneys," J. G. Mingle; "Concrete Roadways for the Industrial Plant," G. S. Eaton; "Effect of Time of Mixing on the Strength and Wearing Qualities of Concrete," D. A. Abrams; "Distortions and Vertical Changes of Concrete Pavement Slabs Due to Subgrade Movements," J. W. Lowell; "Surface Requirements for Concrete Roads," A. H. Hunter; "Progress in Concrete Pavement Design and Construction at Winnetka, Illinois," F. A. Windes; "Concrete Road Construction in Vermilion County, Illinois," P. C. McArdle; "Reinforced-Concrete Columns Under Eccentric Load," L. J. Mensch; "Core Construction," A. H. Bromley, Jr.; "Relation of Costs to Design of Reinforced-Concrete Buildings," C. W. Mayers; "Construction of C. & N. W Railway Grain Elevator," C. F. Huffman; "Construction of Reinforced-Concrete Building for American Can Co.," N. W. Loney; "Flat-Slab Railway Bridges," A. B. Cohen; "Principles of Design of Concrete Ships," R. J. Wig and S. C. Hollister; "Concrete Ships," J. E. Freeman; "Concrete Ships," Archibald G. Monks; "Concrete Barges," O. F. Lackey.

Ten miles of grading were completed last year on the Portage Highway in Manitoba, and the grading of another sixteen miles is under contract for this season. This highway runs east and west through the province. During the past three years, thirty-five miles of it have been completed with permanent culverts and bridges and with gravel surface.

TORONTO WATER FILTERED, CHLORINATED

WORKS Commissioner R. C. Harris, of Toronto, has reported to the Board of Control of that city that the verMehr mechanical filter plant at Toronto Island is now complete with the exception of some minor adjustments of pipe lines, clearing and grading of site, and supply of an overhead crane for unloading coal and chemicals from barges and depositing them in the storage bins. The plant will not be taken over from the contractors finally until these details have been completed. All the units in the plant are now working, however, and all water that is pumped to the city is being filtered either in this plant or in the old slow sand plant. All the water is being chlorinated after filtration, a battery of Wallace & Tiernan liquid chlorinators having been installed some time ago. Col. George G. Nasmith has been asked by the Board of Control to submit a report on the success of the chlorination.

WIDE STREETS OR SUBWAYS?

CITY engineers to-day "are planning not only to solve their immediate transportation problems, but they are endeavoring to anticipate the future," says the Concrete Highway Magazine. "Many experts have agreed that the real solution for traffic congestion which will be effective fifty years hence, as well as relieve immediate congestion, is the adoption of the policy of wider streets and lower buildings.

"Adoption of subway and elevated trains to increase transportation facilities has proven of only temporary relief. The result has been to increase the possibilities for crowding more people into the same business district with consequent demand for higher buildings, more congestion and again increased transportation facilities—an unending chain of problems without a permanent solution.

"Transportation problems are in great measure solved when wider streets prevail. Traffic congestion is less and greater speed can be made between business and residential sections. Cars can be run oftener with increased traffic capacity and with greater safety and comfort. Fewer accidents result, which, aside from a humanitarian standpoint, eliminates a great proportion of the damage suit tax now part of the overhead expense of every transportation company.

"Surface lines on main radial streets with interweaving crosstown lines cover cities in a way which would be impossible for a subway system. The civic policy of wide street construction, now being adopted by many larger cities, offers permanent relief."

The new road over the Coal Harbor causeway, affording direct access to Stanley Park, B.C., is now open for automobile and light vehicular traffic. One section of the causeway next the wall has been graded and levelled, and now offers a fine roadway 16 feet wide. The handsome cut stone balustrade along the sea wall side of the park is finished and the stone columns for the ornamental lighting have been erected.

Under the direction of the highway department of the Province of Manitoba, an 86½-ft. span, reinforced concrete bridge was built last year over the Valley River in the municipality of Grandview. The design is a bowstring truss or open sprandrel arch with elastic abutments, the unique feature being that the floor is suspended from the arch ribs instead of being superimposed as usual in this type of bridge. The thrust from the arch ribs is taken by a horizontal tie at floor level and a system of roller bearings provides for horizontal displacement due to temperature expansion.

NEW 110-MILLION-GALLON PUMP AT THE CHAIN OF ROCKS, ST. LOUIS*

By L. A. Day

In order to meet an increased demand for pumping capacity at the low-service pumping station of the city of St. Louis, a contract was awarded for a new De Laval turbine-driven centrifugal pump having a maximum capacity of 110,000,000 gallons per twenty-four hours. This will bring the total capacity of this station up to 290,000,000 gallons per twenty-four hours, which will be adequate for some time to come. The new pump will be located in the centre pit, there being three pits in all. There are at present two 30,000,000-gallon turbine-driven pumps in this pit. Room was made for the 60-inch suction valve on this pump by channelling off 3 feet of the ledge on the east side of the pit for its entire length north and south. This also provides enough room in the pit for the location of the necessary auxiliaries used in connection with the new pump. The ledge was cut from solid limestone. It was also necessary to tunnel a 60-inch suction line through the limestone for a distance of 40 feet to the suction well which is common to all engines in this station. In addition to the 60-inch suction valve which is located within the pit, stop logs are provided in the wet well for making repairs on the suction valve if needed. The operating floor of the pump pit is 12 feet above the bottom. An automatic push-button electric elevator is used to reach the turbine operating floor from the ground level of the pumping station, which is 45 feet above. The pump will be required to operate under varying heads as the river rises or falls. The average total discharge head will be 60 feet with a minimum of 45 feet and a maximum of 65 feet.

Against Head of 45 to 65 Feet

The discharge pipe will be 60-inch diameter and will drop below the floor and then rise vertically, paralleling the west pit wall. The pipe will be enlarged to 72 inches from a flanged Y, which is 60 inches by 72 inches by 42 inches, due to the north 30,000,000 centrifugal pump discharging its water through the same pipe. The new unit will be provided with a 60-inch hydraulically operated discharge valve close to the Y and the old unit with a 42-inch hydraulically operated valve close up to the 45 degree leg of the Y. The 72-inch line will be extended to the delivery well, which is a common discharge well for all pumps in this station. A 72-inch cast iron Venturi meter tube with a 36-inch throat diameter, the largest cast iron Venturi tube ever built, will be installed just outside of the pumping station.

The pump will deliver from 80,000,000 to 110,000,000 gallons in twenty-four hours against any head varying from 45 to 65 feet. This range of flexibility could not be met entirely with governor adjustment, but will be obtained by opening or closing hand-operated valves on the turbine; the speed of the unit thus obtaining will be further controlled by an automatic governor. This governor will be of the oil relay type, designed to permit of adjustment while the unit is in operation to any point within the required range of speed, and after being adjusted will maintain the required speed within 2 per cent. variation above or below.

*One of a series of four papers on St. Louis Water Works presented before the convention of the American Water Works Association held recently in that city.

The maximum brake horse-power of the turbine will be 1,550 and the maximum water horse-power required, including all pipe friction, will be 1,250; the speed of the turbine under these conditions will be 3,717 r.p.m. When the pump is delivering 80,000,000 gallons of water in twenty-four hours under a total head of 45 feet the turbine will run at 2,946 r.p.m. The pump speed will be lowered by means of reduction gears to 352 r.p.m. when delivering 110,000,000 gallons under 65 feet head, and to 279 r.p.m. when delivering 80,000,000 gallons under a 45-foot head. The guaranteed pump efficiency will be slightly above 80 per cent. under all of the specified head and capacity conditions. The suction and discharge openings to the pump will be 48 inches and the 60-inch suction and discharge piping will be gradually reduced near the pumps to this diameter.

Multi-Stage Impulse Type Turbine

The turbine is of the multistage impulse type and will operate with 125 pounds gauge pressure and 75° superheat. Provision will be made for bleeding 1,500 pounds of steam from one of the low-pressure stages for heating feed water. Bleeding this amount of steam will increase the B.t.u. duty of the unit approximately 3 per cent. The bleeder outlet will be provided with an automatic valve set to carry a pressure of 5 pounds gauge on the exhaust line at all times. The dry vacuum pump is of the horizontal crack-and-flywheel type designed to operate at a speed not to exceed 115 r.p.m. The condensate pump will be turbine-driven, connected to a centrifugal pump by means of reduction gears. The circulating pump will be direct connected to the main unit shaft, and will take its water from the 60-inch suction; after passing through the condenser the water will be discharged back into the main suction pipe. The condenser will be of the water-tube type placed directly under the turbine. Water for circulating purposes only will pass through the condenser, as an excessive amount of friction would have been obtained by passing all of the water pumped by the unit through the condenser, this being the usual waterworks practice. In order to drive as much heat as possible out of the exhaust steam going to the condenser a primary heater will be placed in the condenser and all the condensate from the condenser will be pumped through this heater before going to the hot well or open feed-water heater. The total condenser surface will be 2,825 square feet of seamless drawn brass tubes No. 18 B.W.G., 1 inch in diameter and 12 feet long.

Bidder's Guarantees

The unit was bought on the bidder's guarantees of duty per million B.t.u. consumed by the unit, including auxiliaries and bled steam, with the provision that the total amount of exhaust steam from the auxiliaries, plus the steam bled from the unit, should not exceed 2,200 pounds per hour.

The successful bidder's guarantees were as follow:—

100,000,000-GALLON			
Head in feet	45	60	65
50 circulating water	113.5	120	122
80 circulating water	106.5	113	115
80,000,000-GALLON			
Head in feet	45	60	65
50 circulating water	107	113.75	115
80 circulating water	101.5	108.50	109.5
110,000,000-GALLON			
Head in feet	45	60	65
50 circulating water	114	120.75	121.5
80 circulating water	107	113.50	114.0

The average duty for all of these conditions is 114,562,000 feet-pounds per million B.t.u.'s which is equivalent to a duty of 134,000,000 feet-pounds per 1,000 pounds of steam.

Attention is called to the fact that different duties are obtained with different temperatures of circulating water. This is due to the fact that if the turbine is designed properly, better economies will be obtained with low circulating-water temperatures, owing to an increased vacuum. The average circulating water temperatures for this station throughout the year are 50° for the winter and 80 for the summer. In order to compare bids on this unit the following information was embodied in the specifications:

"One million foot-pounds of duty will be valued at $2,000. That is, if bidder A guarantees 5,000,000 foot-pounds higher duty than bidder B, $10,000 will be added to B's bid for comparison with A's bid."

Bidders were instructed to submit curves showing duties guaranteed when pumping 80,000,000, 100,000,000 and 110,000,000 gallons with circulating water temperatures of 50° and 80° and heads of 45, 60 and 65 feet.

During four-fifths of the time each year the pump operates, it is estimated that it will be called on to deliver from 80,000,000 to 110,000,000 gallons under heads varying between 60 and 65 feet. During the remaining one-fifth of the year, it is assumed this pump will deliver from 80,000,000 to 110,000,000 gallons under a 45-foot head. It was further assumed that the unit will deliver 100,000,000 gallons for one-half of each year under all head conditions and the remaining half it will deliver either 80,000,000 or 110,000,000 gallons in equal parts.

The process may be represented diagrammatically as follows:

100,000,000 GALLONS DAILY

$\frac{\text{Duty at } 50^\circ + \text{Duty at } 80^\circ}{2}$ for 45-ft. head × 1 = ...

Ditto for 60-ft. head × 2 = ...

Ditto for 65-ft. head × 2 = ...

5) Sum

Duty A

80,000,000 GALLONS DAILY

$\frac{\text{Duty at } 50^\circ + \text{Duty at } 80^\circ}{2}$ for 45-ft. head × 1 = ...

Ditto for 60-ft. head × 2 = ...

Ditto for 65-ft. head × 2 = ...

5) Sum

Duty B

110,000,000 GALLONS DAILY

$\frac{\text{Duty at } 50^\circ + \text{Duty at } 80^\circ}{2}$ for 45-ft. head × 1 = ...

Ditto for 60-ft. head × 2 = ...

Ditto for 65-ft. head × 2 = ...

5) Sum

Duty C

$$\text{Resultant Duty} = \frac{2 \times \text{Duty A} + \text{Duty B} + \text{Duty C}}{4}$$

All of the above conditions must be verified by complete shop tests before the unit is shipped. These shop tests must be on the turbine, gears and pump assembled complete. The shop tests must show duties at least those guaranteed by the contractor and checked by the city's representatives.

After the unit is installed it will be subjected to an endurance test of ten days of twenty-four hours each.

The physical data of the unit and auxiliaries is as follows:

Turbine

Make	De Laval
Brake horse-power of turbine	Normal 1,300, max. 1,550
Number of stages	13
Number and diameter of rotors	4—27½-in.; 9—24-in.
Revolutions per minute under maximum conditions	3,720
Method of speed control	Jahn's gov'r through oil relay
Percentage of speed obtainable above and below normal by governor regulations	6 above and 15 below
Percentage of speed obtainable above and below normal by hand-regulated nozzle	Approx. 6 above and 20 below
Net weight of turbine without bedplate, pounds	24,000
Diameter and length of bearings, inches	4½ x 14
Diameter of shaft in rotor, inches	10
Diameter of steam admission, inches	6
Diameter of steam exhaust, inches	36

Reduction Gear

Net weight of reduction gear complete without bedplate, pounds	32,000
Diameter of driven gear, inches	63.4
Diameter of pinion, inches	6
Width of face of gear in pinion, inches	29¼
Tooth pressure per inch, face of gear and pinion, when pump is delivering 110,000,000 gallons per day at 65-foot head, pounds	300
Gear ratio	10.56 to 1
Angle of gear tooth, degrees	45
Mechanical efficiency of gear, per cent.	98
Horse-power consumed by gear under maximum conditions	31

Pump

Net weight of pump without bedplate, pounds	40,000
Net weight of bedplate for complete unit, pounds	15,000
Diameter of impellers, inches	50
Diameter of shaft at impeller, inches	8
Diameter and length of bearings, inches	One 6½ x 18 One 5¼ x 18
Length of shaft between bearings, feet	8⅓
Revolutions per minute, maximum	352
Diameter of water suction, inches	48
Diameter of water discharge, inches	48
Efficiency of pump, per cent. (for normal conditions)	81

Condenser

Condensing surface, square feet	2,825
Diameter of tubes, inches	1
Gauge of tubes	No. 18 B.W.G.
Length of tubes, feet	12
Number of steam passes	1
Number of water passes	2
Size of exhaust-steam inlet, inches	36
Net weight of condenser, pounds	20,800
Diameter of condenser shell, feet	5
Length of shell, feet	14¾

Air Pump

Revolutions per minute	115
Size of inlet, inches	5
Size of outlet, inches	3
Method of driving air pump	By steam cylinders
Weight of air pump complete, pounds	6,400

Condensate Pump

Size of pump, inches	2½
Revolutions per minute	1,800
Size of inlet, inches	2½
Size of outlet, inches	2½

OTTAWA WORKS DEPARTMENT REPORT

During 1917, 1.89 miles of permanent pavements were laid in Ottawa, Ont., according to the annual report of Andrew F. Macallum, works commissioner of that city. This report, which has just been published by the city council, states that 26,248 square yards of asphalt were laid, 3,062 sq. yds. of sandstone block, and 3,130 sq. yds. of creosoted wood block. Following are excerpts from the report:—

The following schedule shows the approximate total area of the various classes of pavements laid in Ottawa from 1895 to 1917, inclusive:—

Class of Pavement	Total Miles including Repaving	Existing Mileage 1917	Total Area laid including Repaving curb to curb	Existing Surface Area, 1917, curb to curb
Asphalt	31.36	31.36	597,392	597,392
Asphalt and stone block	13.68	11.95	357,598	310,663
Asphalt and wood block	1.37	1.37	39,183	39,183
Bitulithic	0.54	0.54	4,600	4,600
Bitulithic and stone block	0.08	0.08	1,700	1,700
Rocmac	0.34	0.34	5,377	5,377
Stone block	0.53	0.47	11,960	10,346
Tarvia	2.91	2.91	47,515	47,515
Tar macadam	4.87	4.87	84,835	84,835
Tar macadam and stone block	0.08	0.08	1,868	1,868
Wood block	1.32	1.32	29,256	29,256
	57.08	55.29	1,181,284	1,132,735

Asphalt and stone block area includes 133,932 square yards stone block.

Asphalt and wood block area includes 15,078 square yards wood block.

Asphalt area and mileage includes asphalt macadam pavements.

Sewers

The Ottawa South trunk sewer was constructed to Main Street, leaving only a half mile to be completed. The material used during 1917 on this sewer was reinforced interlocking concrete pipe. The contract for the manufacture of the pipe was given to Blair & Co., of Woodstock, Ont., at $4.33 for 54-inch pipe and $3.44 for 48-inch pipe delivered along the trench.

The following table shows the lengths laid and cost per lineal foot of local improvement sewers laid from 1908 to 1917, the costs including interest:—

Year	Length in feet	Total cost	Cost per lineal foot	Percentage of average cost per lineal foot 1908-1917
1908	22,454	$ 65,841.66	2.93	102.3
1909	43,316	127,168.60	2.93	102.2
1910	25,925	51,840.47	1.44	50.2
1911	12,231	22,570.22	1.84	64.1
1912	13,960	39,603.28	2.84	98.9
1913	21,700	63,083.22	2.91	101.4
1914	57,200	84,417.20	3.13	109.1
1915	20,687	97,344.87	4.70	163.8
1916	4,359	19,967.72	4.58	159.9
1917	4,292	7,155.31	1.67	58.2
	236,124	$678,992.65		

Street Oiling

During the year, 9.3 miles of macadam pavement were treated with Tarvia at a cost of $8,260.55, and 33 miles were sprinkled twice with asphaltic oil at a cost of $13,898.56. Due to the fact that proper distributers were used on the second application of oil, the cost was $5,228.39 as compared with $8,670.17 for the first application.

Two Austin distributers, costing $300 each, were purchased and attached to the old sprinkling wagons, and besides using less oil they placed the oil in a more even manner. This oiling, besides having a beneficial effect on the roads, also eliminated the dust.

Street Cleaning

Two Mack-Hvass motor flushers, costing $7,815 each, were purchased and each operated for two nine-hour shifts throughout the season. These flushers replaced all but three horse-drawn flushers and besides being more economical kept the pavements in better condition. A reduction in street sweepers, due principally to the efficiency of these flushers, was made from 82 to 55 and the streets maintained in good condition.

Sidewalks

Forty-three sidewalks, having a total length of 2.3 miles, were laid at a total cost of approximately $20,400.

Waterworks

The redistribution system of large mains was finished in August and this had the consequent effect of increasing the pressure throughout the city. The new pumping station at Lemieux Island and overland pipes connecting up with this system also went into operation in November, and the Queen Street station used since only as a standby.

The consumption of water is about double what it should be for a city of the size of Ottawa, but it is the intention of the works department to carry out a general Pitometer survey to locate leaks and reduce this waste.

In 1917 the registered population inside the city limits was 101,549. The average number of Imperial gallons of water pumped daily was 20,938,162. The average daily consumption per capita of population was 206.1 gallons. A total of 183.8096 miles of pipe had been laid, an increase of only 1.028 miles during the year. There were 24,805 services, an increase during the year of 136. There are now 1,347 hydrants. The expenditure amounted to $373,285, or 4.88 cents per 1,000 gallons, while the revenue collected totalled $399,468.

Pitometer Survey

Work was commenced with the Pitometer in the latter part of September. The first district which was surveyed was Rockcliffe, and this part of the water distribution system was found to be wasting very little water.

Tests were then made of the water pipes crossing the Rideau River to New Edinburgh. The 15-inch steel main at St. Patrick Street bridge and the 8-inch main at Botelier Street were found to be in the best condition. The 8-inch main crossing at McTaggart Street, was found to have a leak in the river section wasting about 450,000 Imperial gallons a day. This main was completely cut off and will be repaired in the spring. Two of the valves on the 8-inch main at Sussex Street were found to be leaking very badly at the spindle. One valve alone was wasting slightly over 100,000 gallons. These valves are under water and will have to be repaired when the Rideau River water is low. Several leaks were discovered in W. C. Edwards' yards, and one on Sussex Street, which have not yet been repaired.

The apparatus was then moved to the Chaudiere section. The first main tested was the 8-inch Bronson Avenue pipe crossing the tail-race, and it was found to be wasting over 250,000 gallons per day. The leak was

located and repaired by the diver. The largest leak detected was found on the Montreal Street 8-inch main. This leak was wasting nearly a million gallons per day, and the main was immediately shut down.

The 8-inch Booth Street main to J. R. Booth's mills was found in bad condition, but we were unable to calculate this wastage, as we could not close the feed to the mills. This main should be replaced by a main slung to the bridge, as it will be impossible to repair any leak in the water section of the old 8-inch pipe.

With the numerous small leaks which were detected and repaired and the larger ones already described, a wastage of from 2,500,000 to 3,000,000 Imperial gallons per day was located and for the most part repairs were made. In 1918 it is intended that the pipes crossing the canal, Rideau River and parts of the Ottawa River will be thoroughly tested, besides all districts not covered in 1917.

GOVERNMENT TAKES OVER HALIFAX GRAVING DOCK

IN an announcement by Hon. C. C. Ballantyne, Minister of Marine and Fisheries, regarding shipbuilding prospects at Halifax, it is stated that the government has taken over the Halifax drydock. This dock was built by the firms of S. Pearson & Sons, of London, England, and S. M. Brookfield, Limited, of Halifax. It was subsidized by the admiralty, the Dominion Government and the city of Halifax, each of the three giving $10,000 a year for twenty years.

The site was selected by the admiralty on account of its proximity to the naval dock yard. Considerable rock excavation was necessary. A channel several hundred feet in depth had to be excavated into the harbor in order to give a clear entrance depth of over thirty feet. The dock was difficult and expensive to build. It was the first built in Canada, and is one of only two drydocks on the Atlantic coast in British North America, the other being at St. Johns, Newfoundland. Both of these docks were built about thirty years ago at the suggestion of the admiralty.

Until the "Calgarian" and the "Alsatian" were launched, the Halifax dock was large enough to accommodate any ship in the Canadian trade. It is 575 feet long, 102 feet wide at the top and 70 feet at the bottom, with 30 feet of water on the sill. British and French warships have been docked, also the "Indiana," an American battleship. Several vessels have been docked with cargoes on board. Among these was the "Bremen," 550 feet long; ship, coal and cargo weighing 17,300 tons.

The loss suffered by the dock due to the Halifax explosion was appraised at approximately $400,000. The dock itself received comparatively little injury, but all the buildings, such as coal sheds, pump house, boiler house, machine shop, engine house, etc., were destroyed. The dock was not used from December 6th, 1917, the date of the explosion, to February 22nd, 1918, but was again put into commission on the latter date, although all the broken machinery had not yet been replaced.

It is understood that the government intends to build another drydock at Halifax, one that will be able to take the largest dreadnought or Atlantic liner. It will be 1,000 feet long, 120 feet wide and 36 feet deep.

Since the Halifax dock was built, the government has become much more liberal in its assistance to docks by means of subsidies. The Montreal dock receives about $140,000 a year for 35 years. The Prince Rupert dock receives a smaller subsidy. The government built the first dock at Levis, and are now building a second. The government also built the first dock at Esquimalt and are building a second there. It is understood that St. John, N.B., is to be given a government drydock to be included in the terminal scheme for that port.

The Halifax drydock was owned by the Halifax Graving Co., Limited, of which S. M. Brookfield, a well-known citizen of Halifax, was president.

LETTER TO THE EDITOR

"Canadian Association of Engineers"

Sir,—Just an odd remark concerning the formation of the "Canadian Association of Engineers," reported in your issues of April 25th and May 23rd. It seems to me that an organization of this kind is not necessary outside of the Canadian Society of Civil Engineers, regardless of the fact that Mr. Goedike remarks in his "Letter to the Editor," published in your May 23rd issue: "This association has been forced into existence by conditions as they have been in the past and are at present, and intends to carry on a progressive movement to meet conditions in the future as they arise to the best interest of the engineer."

Conditions as they have been in the society need not necessarily be adopted in the future if the same energy which has organized this association be extended to the society through the right of a thoughtful ballot in electing its representatives.

The purport of the general rules of the society from its inception, even to the inception of the Institution of Civil Engineers of the United Kingdom, one hundred years ago, is to ensure that the engineer's utmost skill shall be placed at the disposal of those who employ him, and that the method of his remuneration shall not involve any conflict between his personal interests and those of the clients whom he advises. This general rule no doubt holds good with the society, although it has been allowed to lie dormant by those who have been in control of affairs.

My personal idea of the matter is that every time an engineering club or association is formed outside the society, that act tends to weaken the society. I believe that all questions concerning engineers should be handled by the main Dominion-wide society, and that that society be made democratic by the weight of the ballot.

New clubs and associations mean additional fees, and, being unnecessary, in my estimation, are, therefore, a waste of money. Besides having pressure applied from two opposing groups within the profession, it will tend to weaken still more that little spark of confidence that the public at present holds for the engineer.

All engineers, I feel, are in accord with the four objects of the association, but probably would rather have the energy of the association applied to the Canadian Society of Civil Engineers.

E. L. MILES, M.Can.Soc.C.E.

Calgary, Alta., May 28th, 1918.

[NOTE.—We are in entire agreement with Mr. Miles' viewpoint, and his arguments are very similar to some of those used by the representative of this paper who attended the association's meeting and successfully urged the prospective members to suspend their meetings in order to give the new Institute a fair chance to show what it can do. The report of the suspension of the meetings, which appeared on page 472 of our May 23rd issue, has apparently escaped Mr. Miles' notice, although Mr. Goedike's letter, which Mr. Miles quotes, also appears in that issue, but upon another page.—EDITOR.]

SOME PHASES OF WORK IN THE DISTRIBUTION SECTION OF THE WATER DIVISION, ST. LOUIS*

By W. A. Foley

THERE are several distinct features of the St. Louis distribution system which do not usually obtain in other municipalities; principal among these may be mentioned the two distinct distributing systems called the high and low. The topography of St. Louis is such that the city maintains these two systems, the first termed high at 125 pounds pressure, the second termed low at 85 pounds pressure.

The low system comprises about 67 per cent. of the pipe mileage, and ranges in size from 3-inch to 48-inch, amounting to 680 miles, supplying approximately 35.4 square miles of area. This system supplies certain districts where the elevation does not exceed 100 feet above the city directrix. It was installed before the confining limits of the city were extended, when the city proper was located on the table land adjacent to the river.

As the city growth pushed forward it was essential that the out-lying districts be supplied with an adequate volume and pressure, and the topography of the land was such that an increased pressure system with high duty pumps had to be installed to meet the demand. The high-pressure district now comprising 330 miles of pipe was decided upon. This system supplies districts in which the elevation exceeds the city directrix by more than 100 feet, and is equal in area to 26 square miles. The two systems are separate and distinct, although there is contiguity in all the mileage, the pipe system being laid out on the gridiron theory. Each is maintained separate and independent of the other by means of valves, which close off one system from the other, thus maintaining the independent pressures. The valves are termed separation valves, being kept closed and tabbed with metallic disks showing the number of each valve and indicative of the valve being shut. In the event a metallic disk is not readily available the cap-nut of the valve is reversed or inverted, which is also indicative of a separation valve.

These valves are not opened except when necessity arises, and in this event the high pressure is allowed to bleed into the low system during the period the occasion demands. They are also opened during the semi-annual inspection of valves, which occurs in May and November, when all valves in the two systems are examined and worked to insure their thorough fitness for any subsequent operation, or as a relief to the crowding of the high service pumps, which occurs during the night, when a few separation valves are opened to relieve the load.

30 to 125 Pounds Pressure

Many of the consumers are so fortunately located that either high or low service is available for domestic supply. The low-pressure extremes range from 30 to 85 pounds, and the high-pressure from 40 to 125 pounds. The business section of St. Louis, being the oldest, is supplied by the low-pressure system, but ordinarily good pressure is obtained, the average for the commercial district, which comprises 483 city blocks or 2⅓ square miles area, being 45 pounds.

Another feature of the St. Louis distribution system is a 36-inch lock-bar steel main in 30-foot lengths with riveted joints 26,700 feet in length, which crosses the heart of the city, and acts as a carrier for either high or low-service feed. This feeder has its origin in the central pumping station and can be operated from an 85-pound head with a delivery of 750,000 gallons per hour, or from an 125-pound head with a delivery of approximately 1,000,000 gallons per hour. The change in this trunk line from high to low service is effected by the operation of a few hand-operated valves immediately in front of the engine house and two hydraulically operated valves at the terminus of the steel main, practically five miles distant, where it is breeched into both systems by means of a Y connection. In times of emergency or excessive draught, this feeder serves as a reserve or reinforcement of either system. Many other communities accomplish practically the same purpose by speeding up pumps in times of fire, but the St. Louis steel line was designed with the purpose in view of acting as a composite carrier on either system, as the need arose.

The essential necessity of present-day distribution is conservative despatch. Mechanical appliances to supplant slow hand labor and the execution of repair work with speed are the chief features of distribution work. Although all water distribution departments have features in common, with reference to the general work, yet each individual system has some little appliance or method of repair which is a special feature of that particular system.

Repair of Broken Mains

Portable pumps driven by air or gas, such as Los Angeles has in service, trench filling by cable drag or auto slip, have been employed in St. Louis, not by the exact method employed by other communities, but by methods which prove more feasible here. During the winter, when frozen soil conditions make the excavation for repairs of broken mains excessive in cost, the St. Louis department has found it practicable to use a blast pan, such as is employed by street repair gangs in asphalt surfacing. This proves an effective method of dissipating the frost and expedites the work of excavation, consequently effecting a saving of both time and labor. In the repair of mains 15 inches in diameter and larger where such repair necessitates the employment of a sleeve, the department finds it expedient to employ what is known as a sleeve-spacer. This simple device is the idea of a local street service foreman, and has proved of great value in such work. The spacer is a sort of turn-buckle affair, which is slipped into position and tightened, so as to prevent movement of pipe when the sleeve is slipped into place, but is serves an ideal purpose in spacing the sleeve so that an even joint can be run around the pipe circumference. Usually four of these spacers are employed in the repair of mains 30 inches in diameter and larger. This device is worthy of adoption, especially where repairs are made in close proximity to a valve and its subsequent closing with its large pressure surface may cause a creeping of pipe at the space where sleeve has been employed.

Constant attention to every detail is becoming absolutely essential for the maintenance of a modern pipe system. Air patrols to release air pockets, constant overhauling of valves and other appurtenances, and absolute attention are the prices demanded in a modern system. Conservation of water by the insertion of valves, so that no great loss of water will result from the scarcity of these necessary valves when shuts are enforced on a distributing system through broken mains, is essential. In St. Louis the practice of lengthy shuts for repairs was common until five years ago. These shuts are generally made in a residential district, and the inconveniences are many. Not

*One of a series of four papers presented before the annual convention of the American Water Works Association, St. Louis, May 15th, 1918.

only does the application of frequent valves mean a conservation of water, but it means inconvenience for fewer consumers, and the convenience of the consumer is the essential feature in water distribution.

Not only does the city of St. Louis study and apply all principles which tend to the betterment of the system, but the department maintains an intelligence bureau holding school for one week's duration twice per year. At these school sessions all employees of the distribution system attend, especially the newcomers, who are fully initiated in the art of cutting pipe, yarning and pouring joints, caulking, assembling hydrants and valves, rigging derricks, the use and names of various tools, and all other little details with which all distribution employees should be familiar. These sessions are generally attended by department engineers, and often the exchange of ideas proves as beneficial to the superiors as to the subordinates. The professor in charge is generally a graduate of the ditch, who has advanced step by step in the service, and is capable of showing the principle by actual demonstration. By teaching the employees the use of tools and allowing them to do the actual work in these practice sessions, the department has always on hand an adequate corps of capable men who can assume the different positions without crippling the service when the occasion demands. All large cities should adopt the idea as it familiarizes the employees with the different methods and use of tools, which proves of inestimable value to the department when "trouble-time" arrives.

CONSERVATION OF ENGINEERS

ENGINEERING COUNCIL, which is an organization representative of the five largest engineering societies in the United States, has forwarded an address and resolution to the United States secretaries of War and Navy, and also to the Provost-Marshal-General and to the members of the Senate Committees on Naval and Military Affairs, dealing with the conservation of technical engineers. The text of the address follows:—

Technical engineers of every branch of the profession who are taking part in the war activities of the army and navy are alarmed at the unfortunate waste of technical training caused by the drafting and enlisting of engineers for regular service with little or no regard for their technical attainments. These technically educated and experienced men are essential to the successful conduct of the war and cannot be replaced. There is continuing evidence that America is repeating in some measure England's mistake of sending technical men into the ranks when they should be carefully conserved for special duties in the fighting forces or on the technical staffs of the army, the navy and the essential war industries.

Thousands of Names Given to Government

These facts have been forced upon the attention of engineers who have been co-operating with the government through the Naval Consulting Board, the National Research Council and Engineering Council. Upon these organizations requests have constantly been made for engineers, chemists and other technical men for a great variety of military services. Thousands of names have thus been furnished to the government departments and bureaus. Engineering Council especially has devoted attention to this personnel work through its committee, known as American Engineering Service, which has available classified lists of approximately 25,000 engineers, and besides unclassified lists of many more. It is from these lists, directly or indirectly, that most of the names have been selected for war service.

Engineering Council was founded by the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers, and other engineering societies are co-operating with it in this service, the total membership represented by these organizations being approximately fifty thousand. Already from 10 to 15 per cent. of the members of these several organizations are in the uniformed services of the country, and it is safe to say that a large majority of their remaining members are in the government civilian service, or otherwise directly or indirectly engaged in the war. Engineers do not seek to avoid fighting, but earnestly desire to be given opportunities for fighting and other services in which they can be most effective and which cannot be performed by others.

It is known that through the Committee on Classification of Personnel in the War Service Exchange (of the War Department) and some other ways, efforts are being made to counteract the tendencies toward the loss of our technical men in the ranks of the army and navy. It is believed, however, that these efforts are insufficient and that they should at once be supplemented by other stringent measures dealing with the subject in the draft boards and recruiting stations.

Resolution Offered

In view of the foregoing, Engineering Council, created to provide means for united action and to speak authoritatively for its member societies on all public questions of common interest to engineers, respectfully offers the following:—

Whereas technically trained engineers are indispensable to the army, the navy and the war industries, in engineering corps, ordnance bureaus and signal corps, in aviation, submarine and tank service, in shipbuilding, and in many other assignments; and

Whereas through draft and otherwise, many of these irreplaceable men have been and are being diverted so that their special qualifications are not being utilized; be it

Resolved that in the opinion of Engineering Council, technically trained men of all ages should be enrolled and conserved for technical duties and special efforts should be made immediately by the War and Navy Departments to find and record such men among drafted and enlisted forces and to assign them to places in which their special qualifications are needed; and be it further

Resolved that Engineering Council offers to assist the War and Navy Departments in locating and classifying such men, if its assistance be desired, provided these departments will give the necessary facilities for collecting information about engineers now in the army and navy, or whose names are upon the selected draft lists.

These resolutions are offered solely in a patriotic spirit of helpfulness.

(Signed), Alfred D. Flinn, secretary, Engineering Council.

The eleventh annual meeting of the Canadian Gas Association will be held in Montreal, P.Q., August 22nd and 23rd, 1918. War time problems of the industry will be the main topics for discussion.

In an address to the National Coal Association at Philadelphia, Joseph Dickson, chairman of the anthracite committee, of the United States Fuel Administration, stated that Canada's allotment of anthracite coal for the coming season is 3,602,000 tons, compared with 3,856,021 distributed last season.

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Principal Contents of this Issue

TORONTO AS A RAILWAY CENTRE

UNDER the above title, the "Toronto Globe" in a recent issue published an editorial urging the Dominion Government to establish the national railway headquarters at Toronto. That city has always been the headquarters of the Canadian Northern Railway, and it would throw many of its citizens out of employment were the headquarters of that road to be moved elsewhere. There is also a great deal to be said in favor of the Globe's argument that Ontario and the West are more favorable to public ownership than are Montreal and the East, and that public sentiment would be advantageous in promoting the interests of state railways, were the headquarters of the latter to be located in Toronto.

On the other hand there are equally strong arguments in favor of Montreal as the headquarters for the national system. If the Grand Trunk Railway be taken over and merged with the Canadian Northern and the Canadian Government Railways, as appears to be the government's intention, more people in Montreal would be thrown out of employment by moving the Grand Trunk headquarters to Toronto, than the number who would suffer by the removal of the Canadian Northern Railway offices to Montreal.

Moreover, the headquarters of the Canadian Pacific Railway will undoubtedly remain at Montreal for many years to come, and it would be very convenient in many ways to have the headquarters of the big privately owned and the big publicly owned system in the same city. Not only would it prove a convenience to everyone who wished to do business with the two systems, but what is more important, it would be very convenient for the officers of the systems, who would undoubtedly have a very large amount of detailed business to transact with each other daily. Montreal also possesses many other natural advantages as a centre of railway activity, chiefly the fact that it is Canada's main port; railway executives must keep in close touch with shipping.

The "Globe's" editorial is probably the first gun in a battle between Montreal and Toronto for the headquarters of the new national railway system. If the government moves the Grand Trunk from Montreal, it will have to face strong protests from that city. If it moves the Canadian Northern, it will have to deal with equally irate deputations from Toronto. To steer a middle course, the government may establish the headquarters at Ottawa. We have reason to believe that there is a strong tendency on the part of some of the officials of the Canadian Government Railways to advocate the removal of their headquarters from Moncton, N.B., to Ottawa. With the growth of that system, and especially with the taking over of the Canadian Northern, Moncton becomes impossible as a railway centre. Should the move be to Toronto, Montreal or Ottawa?

CHLORINE IN SANITARY SCIENCE

SANITARY science has unquestionably been benefited to a very great extent by the discovery of the uses and accomplishments of chlorine compounds. The curves accompanying the article on "Chlorination," by Mr. C. A. Jennings, published in this issue, prove that chlorine has been a powerful weapon in the fight against typhoid. Mr. Jennings does not attribute all of the reduction in typhoid fever death rates to the use of chlorine for the disinfection of water supplies, because sometimes other preventative sanitary measures have been adopted at about the same time; such measures, for instance, as the pasteurization of the milk supply, the elimination of privy vaults, the following up of typhoid cases to determine their cause and to prevent secondary infections, and swat-the-fly campaigns. Nevertheless, the proper filtration and disinfection of water supplies has certainly been by far the greatest contributing factor in the remarkable reductions in the typhoid death rate which are shown by Mr. Jennings' statistics.

COMPETITION AFTER THE WAR

WHETHER there will be a war after the war, lies in the lap of the gods. Free-trade England is not quite so wedded to Cobdenite theory as in antebellum days, and is disposed to carry on an economic offensive against the Central Powers after the signing of peace. The United States has within recent months taken over alien enemy property of a corporate or business character, including the mines, timber limits, wharves and shipping owned by German corporations and individuals. Both the United Kingdom and France realized too late the hold that German finance had secured on vitally important national enterprises; and in both nations, notably in France, there is a determination that German capital with its programme of "peaceful penetration" must not be

given the opportunity to aggrandize itself and ever again place national interests in danger.

Fortunately for Canada, the chief capital investments in this country were made by the United Kingdom and the United States. From the Motherland and the Republic, capital will come in the years succeeding the war according to the Dominion's necessary requirements; and, needless to say, such investments will be welcomed. It is only natural, however, to expect that the Dominion will set its face against any policy of economic penetration that Germany may attempt on this side of the water. Whether the brutality and arrogance of the Central Powers will compel the Allies to create an economic combine against them, in self-defence, has yet to be determined; but it is evident that world-wide competition, in any event, will be keener after the war than has ever been experienced before.

Canadian and American manufacturers have yet a great deal to learn from Germany with regard to the efficient marketing of their products. And still in another particular, hardly less important, Germany has surpassed the world in the sphere of industry and commerce; attention to detail lifted German industry to its important position; and it is that same attention to detail that has permitted the enemy to survive, unfortunately, so long as he has done.

It may be admitted that in the great standardized industries of Canada and the United States, the main economies have been effected; but certain details in achieving economies have been overlooked—economies that may make all the difference between success and failure in the fierce competition that will ensue at the close of hostilities. It is wise to increase one's economic knowledge, even if the lesson be taught by the vilest enemy.

It is patent that many small economies can be effected, both in shop and office—by the keeping of fewer and better records in the office, by the avoidance of duplication, and by so organizing the work that computations need not be undertaken again and again for the same kind of job. And in the shop, chemical analyses of metals will perform wonders in reducing the costs of manufacture; castings in the foundry may be made smaller and so require less finishing; designs and costs may be worked out with greater detail and care. The truth is that, in many Canadian and American plants priding themselves on their output, only the rudimentary work of organization has been carried on. Filing systems have become obsolete; there is unnecessary and wasteful shifting of men on jobs, the natural breaks in the work, at noon and morning, not being regarded; and, much more, there is no full utilization of machinery.

In many industries there is a "slack" season for both workers and machines, a slowing down in the process that makes for the waste of both capital and labor. By efficient planning it is often possible to carry over jobs for such slack periods, just as the progressive farmer makes work for rainy days. Some managers, in factories turning out standard products, install machinery with a view to its utilization in dull time on other types of work. This is important when markets are narrow for the main output. Moreover, by the use of high-speed tools, by reducing time wasted between jobs, by the full utilization of the equipment, important economies in labor may often be achieved.

Hon. J. A. Tessier, Minister of Roads, recently made a tour of inspection of the highway between Sorel and Montreal to investigate the claim for proposed changes made by residents of that district.

PERSONALS

C. J. Brittain, manager of the Winnipeg branch of Canadian Fairbanks-Morse Company, Limited, has been elected to the directorate of that company.

F. P. Knopp has resigned as shop superintendent of the bridge department of Canadian Allis-Chalmers, Ltd., Toronto, to take charge of two ways for the Submarine Boat Co. at Newark, N.J.

Herbert J. S. Dennison, the well-known patent attorney, of Toronto, has moved his offices from 18 King Street West to the Kent Building, corner Yonge and Richmond Streets, Toronto.

Llewellyn N. Edwards has resigned from the works department of the city of Toronto and has reported for service at Camp Lee, Petersburgh, Virginia, having received a commission as captain in the engineering reserve corps.

James C. Johnstone, former city engineer of Port Alberni, who is now with the 1st Canadian Pioneers, and who has on several occasions been promoted, has recently received appointment as major.

John J. Scallon, for many years general superintendent of the Davenport Works of Canadian Allis-Chalmers, Limited, Toronto, and previously of the Canada Foundry Co., has been appointed manager of hull construction for the Submarine Boat Co., of Newark, N.J. This new plant will have fifty ways, of which about thirty are completed and have keels laid.

F. J. Brule, assistant general manager of the British American Nickel Corporation, has transferred his office from Sudbury, Ont., to Deschenes, P.Q., where the new plant of the corporation is being erected. With Mr. Brule there have been transferred the following engineering staff: D. Van Doren, chief engineer; Louis Whitman, office engineer; C. D. Norton, field engineer; and R. Guy, draftsman.

A. W. Haddow, who has filled the position of acting city engineer for Edmonton, Alta., since the retirement of the late A. J. Latornell, has been appointed by the city commissioners to the post of city engineer. Mr. Haddow's home is in Simcoe, Ont. He went to Edmonton in 1909, having previously been connected with an engineering firm in Northern Ontario. In 1911 he was appointed assistant city engineer, and in July, 1915, was given the position of acting engineer.

Lieut. H. N. Darling, of Toronto, Ont., who went to France with the first Canadian Pacific Railway Battalion of Railway Construction, has been awarded the Military Cross in recognition of his bravery and devotion to duty in saving a large amount of valuable railway equipment during the operations around St. Quentin in the early spring. Lieut. Darling was the first of his battalion to be promoted to a commission and the first of his unit to be awarded the Military Cross.

OBITUARY

Michael Chapman, formerly of Chapman & Walker, of Toronto, died in France recently. Mr. Chapman took the officer's training course in 1915 with the Royal Grenadiers and later obtained a commission with the Grenadier Guards in England. He leaves a widow and two young children.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Are Good Roads Remunerative to Municipalities?

Experience in Massachusetts Throws Some Light Upon the Question, Do Good Roads Pay?—Increased Amounts of Taxes Are Collected Due to Rise in Land Values Directly Caused by Road Construction

By COL. WILLIAM D. SOHIER
Chairman, Massachusetts Highway Commission

WHEN I attended the Canadian Good Roads Congress at Hamilton last week, I gave some statistics regarding the value of good roads—their actual dollars and cents value—which the representative of *The Canadian Engineer* thought were interesting, and he made me promise to write an article giving some more detailed data in answer to the question, "Do good roads pay?"; or more exactly, to the question, "Are municipalities remunerated for their expenditures on good roads by the increased taxation due to rise in land values occasioned by the construction of the roads?"

To begin with, I will cite some experiences we have had in Massachusetts. The figures I will quote are in round numbers. I have left off the hundreds and sometimes the thousands, because they are of no value, comparatively speaking.

We must realize that there are so many considerations other than roads that may enter into increased land values, that it would be very difficult to prove that all of these increases were due absolutely and solely to better roads. At the same time, there is no doubt in my mind that good roads have been very largely responsible for the increases in valuation, and particularly in localizing them in places which have become favorite summer-resident resorts, the particular portion of the town that was served by good roads having developed and other equally good localities on the seashore, for instance, not having developed; though, of course, this does not show in the valuation of the town.

Lathrop Road, Near Beverly, Mass.

In Massachusetts, the municipalities of Beverly and Manchester had good roads really back as far as 1895 and thereabout. Wenham, Hamilton and Ipswich were also connected up with improved roads. Essex, lying between Hamilton and Gloucester, has some fine beaches, sand dunes, and a river, but the road has not yet been built.

Massachusetts State Highway, South Sudbury

The following are the valuations in 1900 and 1915 respectively, with the percentage of increase:—

	1900.	1915.	Percentage increase.
Beverly	$16,000,000	$44,000,000	175
Hamilton	2,299,000	6,000,000	161
Ipswich	3,245,000	5,634,000	73
Topsfield	859,000	4,294,000	400
Middleton	569,000	923,000	62
Wenham	1,000,000	3,662,000	266
Manchester	8,700,000	20,000,000	129
Essex	977,000	1,315,000	34
Boxford	688,000	1,338,000	94½
Newbury	979,000	1,600,000	63
Georgetown	1,000,000	1,365,000	36½

Beyond Ipswich is Newbury, which was not connected up on a through route until lately. Beverly, Wenham, Hamilton and Ipswich are all connected with a good road; hence their valuations. Hamilton, Wenham and Ipswich are farming towns, although Ipswich has a little seashore.

Topsfield was connected with a good road to Hamilton in the year 1900. It is also a farming town, as is George-

town. Two other towns only just connected up with improved roads, are Middleton and Boxford.

Improvements on Cape Cod

Improved roads were built in Bourne, Yarmouth and Barnstable by 1900. They are seashore towns, as is also Falmouth, whose roads were improved in 1905 to 1908. Their valuations in 1900 and 1915 were as follows:—

Bourne	$2,141,000	$ 7,350,000
Yarmouth	1,785,000	2,521,000
Barnstable	4,328,000	9,347,000
Falmouth	7,342,000	16,862,000

Sandwich, which lies between Bourne and Barnstable, only secured a good road connection two years ago, although it is on the seashore and also on a through route. Her valuation in 1900 was $971,000; and in 1915, $1,494,000. This again shows that the towns that are connected up on the seashore that had good roads early, are at least the ones that developed most.

The value of these improved roads is also shown in the fact that in Barnstable county, with fifteen towns in all, the valuation increased from $24,206,000 in 1900, to

Paradise Road, Swampscott, Mass.

$53,138,000 in 1915, an increase of 119½ per cent. Five of these towns in this county that had good roads increased in valuation from $16,150,000 in 1900, to $43,875,000 in 1915, an increase of 171 per cent., or 96 per cent. of the total increase in the county. The remaining ten towns increased in valuation during these fifteen years $1,209,000, an increase of only 4 per cent.

Taking some of the little interior towns on Cape Cod:—

Carver began to improve its roads very early. Its valuation in 1900 was $908,000; in 1915, $2,000,000.

Pembroke also improved its roads. Its valuation in 1900 was $623,000; in 1915, $1,246,000.

Plympton in the immediate neighborhood had no good roads. Its valuation in 1900 was $331,000; in 1915, $464,000.

Western Massachusetts

Going into the western part of the state, among towns that raise apples, milk, etc., Ashfield and Buckland were connected up by a good road prior to 1900.

The valuation of Ashfield in 1895 was $496,000; in 1915, $906,000. This town had a good road to the same railroad station as the adjoining town, Buckland, but had a five-mile longer haul. The valuation of Buckland in 1895 was $550,000; in 1915, $2,000,000.

Conway is a little farming town next to Ashfield; had no good road; not yet connected. Its valuation in 1895 was $681,000; in 1915, $833,000.

Hawley is an adjoining town on the other side, a farming town not connected with a good road. Its valuation in 1900 was $141,000; in 1915, $242,000.

To cite some farming towns in the extreme western part of the state:—

The town of Richmond began to improve its roads many years ago. In 1900 it had a valuation of $326,000; in 1915 the valuation was $621,000; and I am informed that all of this increased valuation came on the land within a half mile of the improved road which runs the length of the town.

Attracts the Summer-Home Builders

A little town in the same county which is not connected with a good road as yet, the town of Savoy, had a valuation in 1900 of $157,000; in 1915, $196,000.

Take another town in the same county, a farming town that is not as yet connected with a good road, Monterey; valuation in 1900, $226,000; in 1915, $385,000.

An illustration of a town in that neighborhood which has improved roads and also is a somewhat fashionable summer resort, is Lenox. Its valuation in 1900 was $3,700,000; in 1915 it was $8,470,000.

It is very noticeable that where we start to build a road through the country in the western part of the state, which is full of wooded hills and brooks, that often before the road is built, but after it is started, the summer people come in and buy up abandoned farms and erect good houses. I have one town in mind where the road will not be built for two years, but since we began five years ago, it has had five such summer residents locate there and build houses, the houses probably averaging in cost from $8,000 to $25,000. Often these new residents run quite large farms.

In some ways there is an even stronger argument for good roads than the increase in land values. A practical one is the actual saving to the farmer; which, however, really increases the actual value of his farm.

I have a letter from a man who owns a large farm in Orillia, near Seattle, Washington. He was thirteen miles from his market, making a haul of twenty-six miles a round trip. He could only pull with a pair of 1,700-lb. horses, 2,500 pounds of cabbages at a load, and it took him 12 hours on the old unimproved roads. An improved road was built, and he now hauls 5,000 pounds and can make the trip in 9 hours.

How the Farmers Save Money

Calling the team worth $5 a day, he saved 30 days in hauling the cabbage crop to market,—75 tons of cabbage. If the team be worth $5 a day, that means a saving of $150 on 75 tons, or $2 a ton; and, of course, he could use his team for the thirty days on some other work.

This man, Frank Terrace, stated that the farmers in his neighborhood produce milk; that the city of Seattle consumes 35,000 gallons of milk and 4,000 gallons of cream a day. There was an average haul to the railroad of 2 miles; they had to deliver the milk at the depot early in the morning; the railroad carried the full can and brought back the empty at one cent a gallon; then the retailers had to collect the cans at the railroad station in Seattle.

Since the new road was built, the farmers put their milk out on the road at their farms, and a truck collects it and delivers it to the distributing station in Seattle, thus

saving two handlings; and the truck people only charge a half cent a gallon for the service.

The saving on this milk alone amounts to $195 a day, to say nothing of the saving in time for the farmers, cost of teams, etc. This saving amounts to $71,000 a year.

More Than Pays for Road

If this be compared with the cost of the thirteen miles of road, say, even if the road cost them at to-day's high prices, $20,000 a mile, that would equal $260,000; interest at 4 per cent., $10,400; twenty-year serial, $13,000 a year; or an annual charge, including interest, of $23,400 for a saving of $71,000 to the farmers on the milk alone.

If you figure their savings on cabbages alone at $150 a year, and leave out the thirty days that the teams could be used for something else, that equals a tax rate of $1 per $1,000 on a $150,000 valuation, which would be quite an extensive farm.

In one of our Massachusetts towns that raises apples, they had about an eleven-mile haul to the railroad station. The teamsters tell me that in the old days they hauled apples at fifty cents a barrel. Since the roads have been improved, they are now hauling the apples at twenty-five cents a barrel and are hauling three times as many barrels to the load; so the teamsters are collecting fifty per cent. more money, and the farmer is only paying fifty per cent. of what he formerly paid per barrel. Also on the return load, as the grade has been improved as well as the road, they are hauling three times as much grain or coal back to the town, which happens to be the town of Ashfield that I mentioned above.

I stopped some of the farmers about ten miles out from the city of Detroit, in Wayne County, Michigan, and asked them what the concrete road built there had done for them. They differed. Two told me that they hauled three loads a day over an ordinary country road in bad weather, and that when the road was improved they loaded what would equal the three loads onto one load, and carried it into town with much greater ease for the horses than when they had only one-third of the load. Five or six others said about the same, only that they hauled two loads to the one load.

Road Brings Twenty-six New Houses

In many parts of Massachusetts, we are now hauling an average of three tons to a load, with two horses, where before the road was improved they could only haul three-quarters of a ton. This is in the sandy section of the state. On the ordinary dirt road, the amount that can be hauled has more than doubled; and where grades are improved as well as the road, the amount has trebled.

In France they consider three tons as a one-horse load. In order to enable horses to pull three tons they had no grades on the main roads exceeding five per cent. They always figured formerly that it cost eight cents per ton per mile to haul farm products. We figure in this country that it costs twenty-five cents per ton per mile over an ordinary road.

I might add also that on one stretch of road, 1½ miles long, just completed last fall in Arlington, there have already been three streets opened up connecting with it; farming land has been cut into building lots; and twenty-six houses, costing from $2,500 to $4,000 each, were constructed before the road was completed.

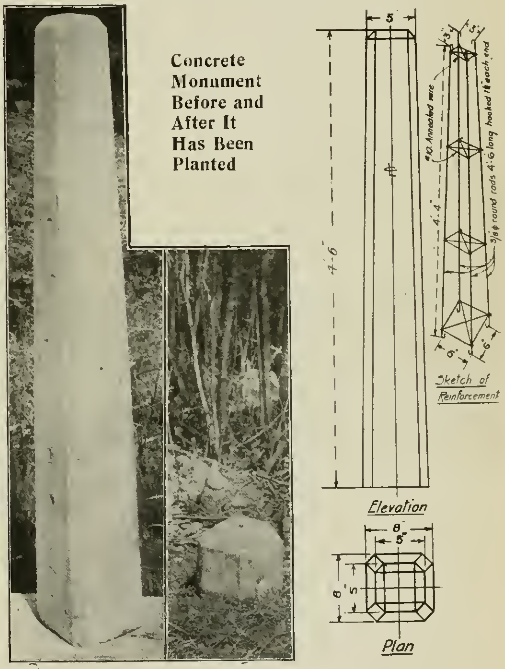
On a road that we built in Gloucester, a mile long, 28 houses out of the 38 were repainted, four new piazzas were added, and a number of improvements like fences, etc., were built, greatly improving at any rate the appearance of the locality.

HIGHWAY SURVEY MONUMENTS

By Geo. Hogarth
Engineer of Highways, Province of Ontario

It is necessary on provincial highways that the limits of the road allowance should be monumented in an easily interpreted manner, in order that the companies and people interested in the highway may know or may be able to ascertain readily the lines marking the sides of the road. Such monumenting is a convenience to the people. When new fences and buildings are constructed, it is then a simple matter to identify the boundary of the land fronting on the highway, and the fence can be built accordingly.

Encroachments on highways by fences and buildings are not unusual and in many places the actual width of the road between fences is frequently less than the registered width. To provide for the different public services, such as power, telephone and telegraph lines, requires that every foot of width be used to advantage, so that the delimiting and monumenting of the road is an important matter.



Concrete Monument Before and After It Has Been Planted

Monuments suitable for such work should be permanent so far as possible; they should be indestructible and of such a size as to discourage their easy removal. They should also have a composition which would not prove tempting to souvenir hunters.

Evidently wood is an entirely unsuitable material as it is not permanent and is liable to easy destruction or removal. A metal post was considered by the Department of Public Highways of Ontario, and the excellent monuments of the Dominion Lands Survey were carefully examined and the costs enquired into. Metal posts used by other Dominion and municipal departments and com-

missions were also examined. The experience with metal posts in a settled community is that the metal proves tempting and the posts or caps do not remain in the original position very long.

Concrete survey monuments have been used with success in southern Ontario for some time and several satisfactory designs are in existence. After careful search of all existing information on such monuments, the design shown in the accompanying drawing was prepared. The length of this monument is 4½ feet, with the base 8 inches square and top 5 inches square, giving a taper of 1½ inches to the sides, with a 1-inch chamfer at each corner. Steel reinforcing bars are placed in the corners of the monument, the bars being ⅜-in. round, with the ends hooked. To prevent splitting of the concrete, the bars are wound at four places with No. 10 annealed steel wire. A centre point is provided by placing a piece of No. 10 copper wire in the top of the monument. This piece of wire is 6 inches long and bent so as to anchor to the concrete. After the concrete in the monument is set, the wire is cut off flush with the surface, and the top of the monument rubbed down with a carborundum stone.

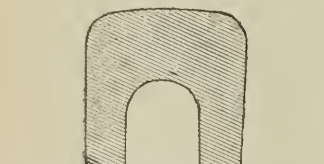
In February, 1918, the department made tests east of Toronto to determine the depth of frost penetration, and in one exposed location it was found that the frost had gone down three feet eight inches. Short square monuments are sometimes heaved by the frost, but the taper given this design and the depth of slightly over four feet to which they are planted, give sufficient assurance against displacement.

These monuments contain 1⅓ cubic feet of concrete and weigh approximately 200 pounds. During the past winter, when outside work could not be carried on to advantage, farm buildings convenient to the roads to be marked were secured and a number of the monuments cast ready for the construction season. Only a sufficient number to monument a road across one township were cast at one location, and they are being distributed on short hauls by teams or steam tractors as occasion requires. Ordinary post-hole digging tools have been found satisfactory for opening an excavation of the proper dimensions.

LETTER TO THE EDITOR

Old Grand Trunk Rail

Sir,—Enclosed please find section of Grand Trunk Railway 1856 rail, which may be of interest. We received a short piece of this recently for the Waterloo Historical Society, which is accumulating something of a transportation museum. Our specimen is considerably rust-pitted. It weighs, as it is, about 59 lbs. per yard; probably the original weight was 60 lbs. per yard. You will note that the base is not quite a plane and that the top surface shows apparent slight wear.



W. H. BREITHAUPT, C.E.

Kitchener, Ont., June 3rd, 1918.

SOME ASPECTS OF CHEMICAL TREATMENT AT ST. LOUIS WATERWORKS*

By A. V. Graf,
Chief Chemist, St. Louis Waterworks

THE principal streams contributing to the water supply of the city of St. Louis are the Mississippi, Illinois and Missouri Rivers. The Illinois River enters the Mississippi thirty-three miles north of the intakes at the Chain of Rocks, and in traversing this distance a more or less intimate mixture of the two waters is effected. The Missouri River enters the Mississippi five and a half miles north of the intakes, and causes a pressing of the Mississippi River water upon the east bank of the river, and in this way, as a rule, very little mixing of the two waters occurs by the time the water reaches our intakes. At times the turbidity of the water on the west side of the river is ten times as great as that of the water on the east side, and at other times the color of the east water is 25 parts per million greater than that of the west water, showing the incompleteness of the mixing of the two waters. With a high stage in either river and a low stage in the other, the mixing of the waters is more complete.

Mississippi, Missouri and Illinois Rivers

The waters in each of these rivers have certain characteristics which become of greater or less interest as the stages of the rivers vary. The Mississippi River drainage area being covered with swamps, the water in this river becomes highly colored at times of heavy run-off, while the Illinois River, carrying a large amount of sewage, contains colloidal organic matter, which seems to act as a protective colloid on the turbidity carried by this river. The water in the Missouri River, always turbid, becomes much more so at times of heavy run-off. The dissolved solids in these waters vary considerably, but dissolved solids offer no difficulty in the treatment of the water, and are, therefore, of less interest.

The river water enters our plant through two intakes, one, the old, or west, intake, 1,500 feet east of the west bank of the river, and connected to the wet well by a 7-foot circular, brick-lined tunnel, 2,197 feet long. The other, or east intake, is 700 feet east and 200 feet north of the west intake, and is connected to the wet well by an 8-foot circular, concrete-lined tunnel, 2,747 feet long.

The water drawn through the west intake is principally Missouri River water for the greater part of the year, while the water drawn through the east intake is that of the mixture of the Mississippi and Illinois River waters, although at times the water at both intakes is practically the same, both chemically and physically.

150,000,000 Gallons a Day

The east intake was in service only ninety-seven days during the past year, whereas the west intake was used for three hundred and fifty days. Because of the greater difficulty of treating the water from the east intake, this is not used unless low stages of the river or anchor ice, or both, are affecting the pumping.

The water entering the tunnels flows by gravity to the wet well, whence it is pumped, against a dynamic head of 58.3 feet, into the delivery well, and flows from there to the grit chamber, where the average velocity of flow, at a rate of pumping of 150,000,000 gallons per

*One of a series of four papers on St. Louis Waterworks presented before the convention of the American Waterworks Association, held recently in that city.

day, is only 0.33 foot per second. In this chamber the coarser and heavier part of the suspended matter is deposited, the amount removed depending upon the character of the suspended matter, as well as upon the amount present in the water. The efficiency of the grit chamber is shown in the fineness of the material removed, over 50 per cent. of the matter deposited passing a 100-mesh sieve. The tons of matter removed by the grit chamber during the past year was 63,703, or 23 per cent. of the total suspended matter present in the water.

Chemicals Pumped to Mixing Chamber

Leaving the grit chamber, the water flows through a short conduit to the mixing chamber, where milk of lime and a solution of sulphate of iron are added. These chemicals are prepared in the coagulent house for addition to the water, and are pumped a distance of 900 feet to the mixing chamber.

The lime is weighed out in automatic scales, and is dumped into circular slaking tanks, which are provided with revolving rakes. The temperature of the milk of lime in the slaking tank is kept at 200° F. This is accomplished by keeping up the temperature of the fresh water supply by passing it through the coils of a heater tank into which the milk of lime at 200° is drawn. From 4 to 4½ pounds of water per pound of lime are used in slaking. The water overflowing from the water tank is run into a cooling and diluting box, where the temperature is reduced to as low as 64° in winter time to 108° in summer. The strength of the milk of lime as pumped is 38,600 parts per million of CaO.

A slaker tank is kept in service until the accumulated unslakeable material is great enough to impede the motion of the rakes. From 50 to 150 tons of lime are slaked before a tank is taken out of service, the amount depending upon the purity of the lime. Tests made to determine the effect of limes of varying percentages of CaO upon the amount of lime that could be slaked before a slaking tank had to be taken out of service showed that for every increase of 1 per cent. in the available CaO, above the lowest lime tested, an additional 10 tons could be slaked. Contracts for lime are let under a specification requiring a lime of 85 per cent. CaO, with a bonus or penalty of 1.5 per cent. for each 1 per cent. above or below the required 85 per cent.

The Mixing Conduit

The sulphate of iron is measured by passing it through an adjustable orifice on to the surface of a cylindrical drum, revolving at a constant speed, and is discharged in a continuous flow into a tank, where it is dissolved without stirring by water entering through a manifold at the bottom of the tank, the solution being drawn off through an overflow.

The mixing conduit, into which the chemicals are delivered, is a reinforced concrete box, 2,382 feet long, 32 feet 1 inch wide and 12 feet 6 inches high, divided longitudinally into four compartments, each 7 feet wide and 11 feet high. The four compartments are supplied with stop-plank openings so that they may be thrown in parallel, used in series or withdrawn from service for cleaning. In normal operation the water enters the west channel and travels the full length four times, a total of 9,528 feet, having an average velocity of 3.3 feet per second when the rate of pumping is 150,000,000 gallons a day.

Provision is made so that the lime or iron may be added to either of the four compartments, but the lime is added, for the greater part of the time, to the raw water as it enters the mixing conduit and the sulphate of iron as it leaves the conduit. The period of mixing averages about one hour. The sides and bottoms of the first two compartments are bady coated; the coating on the sides is practically all calcium and magnesium carbonate, and magnesium hydroxide while the bottom coating consists of the sand and unslakeable material present in the lime added bound together by the precipitated calcium carbonate and magnesium hydroxide.

The value of the mixing chamber is shown by an occurrence of last year. A leak in the south end of the mixing conduit, due to the failure of the contractor to properly plug a drain, caused the conduit to be taken out of service. The water was passed from the delivery well direct to the first of the sedimentation basins the sulphate of iron being added in the tunnel at the coagulent house and the milk of lime at the delivery well.

Value of the Mixing Chamber

The turbidity of the water in the delivery well was 2,500 at the time and the turbidity of the water in the last of the sedimentation basins was 20, the amounts of chemicals added being 6.25 grains of lime per gallon and 0.25 grain of sulphate of iron. After the mixing conduit was taken out of service, the sulphate of iron was increased to 2.50 grains per gallon, the lime remaining the same. In forty hours the turbidity of the water, in the last of the sedimentation basins, increased to 40, the turbidity of the river water remaining practically the same as on the preceding days. By adding ten times the amount of sulphate, the results were still inferior to what was accomplished with the mixing conduit in use. The additional cost due to the use of a larger amount of sulphate of iron while the conduit was out of service, one and one-half days, was $390.

The points of application of the milk of lime and sulphate of iron depend upon the condition of the raw water. With a water high in color and low in turbidity the iron is added before the lime with good results. If the high color is accompanied by a turbidity of 200 to 300 parts per million, better results are obtained by adding the sulphate of iron as the water leaves the mixing conduit. With high turbidity the lime is always added at the first opening and the sulphate of iron at the last. With low color and low turbidity due to colloidal matter, the sulphate of iron is added at the third opening, which allows a mixing through one-half of the conduit. At times, with finely divided suspended matter in our raw water, the only sedimentation that takes place is accomplished in the first basin, the turbidity of the water in the last of the sedimentation basins being as great as that of the water leaving the first basin.

Color is Increased Sometimes

With high stages in the Mississippi and Illinois Rivers and a low stage in the Missouri, we encounter our worst condition. The high color of the Mississippi, together with the colloidal matter in the Illinois, make a water hard to handle. The use of sulphate of iron as a coagulant at these times is accompanied by some difficulty. The coloring matter of the water combines with the iron, and instead of a diminution in color, the color is increased. The suspended matter being really colloidal and some of the iron hydroxide remaining in the colloidal condition, the turbidity of the water after sedimentation is greater than that of the river. This highly-colored and turbid water is much less amenable to treatment with sulphate of alumina. The amount of sulphate of alumina required to give the required flocculation of the suspended

matter is from 4 to 5 grains per gallon. With this large amount of sulphate, the water passing the filters is clear but is still of high color, the iron content being eight to ten times as great as normally. At times, when this condition occurs, no relief is experienced until the Missouri River run-off increases, and thereby gives us a turbid water which offers enough suspended matter for the rapid subsidence of the floc of ferric hydroxide. The more turbid the water at our intakes, the less trouble we have with turbidity causing material remaining in suspension.

Operation Record for Year Ending February 28th, 1918

Chain of Rocks

		Basins out of service	Days out of service	Remarks
Water pumped (Chain of Rocks) in million gallons	39,289.23			
Water consumed in million gallons	38,024 64	No. 1	24	Basins cleaned:
Water filtered	39,351 70	No. 2	24	No. 1 May, July, November, mud 128 inches
Water used in filter house operation	805 22	No. 5	11	No. 2, May, July, mud 87 inches.
Water used in coagulant house operation	97 95	No. 6	14	No. 6, November, mud 45 inches
Water used in basin operation (filtered)	278.49	No. 8	123	No. 9, August, mud 46 inches.
Water used in basin operation (unfiltered)	593 04	No. 9	9	
Water used in purification. Total	1,774.70			

Chemicals used

Description	Pounds	Grains per gallon		
		Maximum	Minimum	Average
Lime	30,147,933	8 00	4 00	5 371
Sulphate of iron	4,294,689	2 50	0.00	0.765
Sulphate of alumina (meters)	3,781,163	3 68	0.11	0 673
Sulphate of alumina (influent)	29,560	0 25	0 00	0.005
Sulphate of alumina (filters)	108,756	14 pounds per wash	0 pounds per wash	0.019 grains per gallon
Chlorine	74,516	4 pounds per million gallons	0 pounds per million gallons	1.89 pounds per million gallons

Variations in water

Description	River water			Settled water			Applied water			Water to bs. pumps		
	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.
Stage of river	105	74 9	78 4									
Temperature	84	32	54									
Turbidity, parts per million	5.000	8	1,240	110	9	24	32	4	10	0	0	0
Color, parts per million	48	10	22	35	6	14	32	6	12	28	4	9
Suspended solids, parts per million	6,930	6	1,700							0	0	0
Dissolved solids, parts per million	468	190	310							370	150	215
Total solids, parts per million	7,210	400	2,010							370	150	216
Alkalinity total, parts per million	233	93	145	146	32	60	136	27	56	127	26	53
Alkalinity caustic, parts per million				8								
Alkalinity bicarbonate, parts per million	233	93	145	122		20	120	0	28	115	8	29
Hardness total, parts per million	304	116	193							188	66	108
Bacteria gelatine, per cubic centimeter	625,000	600	55,500	7,000	59	1.020	4 800	53	710	530	2	98
Bacteria agar, per cubic centimeter	27,000	110	7,300	450	15	97	290	9	57	57	2	11
Coli, per cubic centimeter	80	0.2	17 2			0.259			0 271			0.0106

Number filters in service 40	Run of filter in hours: Max. 206.75; Min. 6.92; Av. 50.2	Bacteria agar effluent 16
Number filtering hours 343,743	Run of filter in million gallons: Max. 22.63; min. 0.876; Av. 5..67	Bacteria gelatine effluent 185
Average rate filtration, million grains daily 85.39	B. coli per cubic centimeter in effluent 0 0485	
Rate of wash, gallons per million 21,000	B. coli per cubic centimeter tap water average 0.0121	
Number of washes 8.931	Bacteria agar. Tap water average...10	
Per cent wash water used 1.56		
Average gallons used per wash 78.990		

After passing through the mixing conduit, the water enters the first of six sedimentation basins, each 400 feet long by 670 feet wide, of 30,000,000 gallons capacity. The first three division walls have five stop-plank openings and the last two four openings, all $4\frac{1}{2}$ feet deep by 8 feet long. These openings render the sedimentation basins less efficient than would wiers extending the full width of the basins, but because of the necessity of maintaining an elevation of the water but little lower than the top of the basins, the need of stop-plank openings at times of cleaning is apparent. The time of sedimentation, based upon the capacity of the basins, varies from thirty to forty-three hours, but the actual time is much less, the effects of a change in the amounts of chemicals added being noticeable in twelve to fifteen hours in the last of the basins. About 90 per cent. of the suspended matter and bacteria are removed in the first basin and 9 per cent. in the remaining basins.

The total amount of matter removed from the water during the past year, including the chemicals added and the dissolved solids removed, amounted to 326,775 tons, or 484,111 cubic yards. Some of the mud was removed by opening the sewer-gate for one-half hour at varying intervals, but the greater part was removed from the basins by labor and teams. The teams are used to draw scrapers, which cut off portions of the mass of mud and drag them to the central gutter, through which water is flowing. The men are provided with scrapers, which are used as such, and also as braces to keep small A-shaped boxes in place, as the mud drawn by the horses and the water used to aid in removing the mud are drawn by the boxes. The cost of the removal of the mud from the sedimentation basins, not including the cost of the water, was 0.762 cent per cubic yard for the past year.

The water leaving the sedimentation basins enters a collecting conduit and passes through two 8-foot Venturi meters and into a small secondary coagulation basin, connected to secondary sedimentation basins by stop-plank openings. The solution of sulphate of alumina is added at the throat of the meters, and is automatically controlled so that the quantity added per unit is constant for any setting, regardless of fluctuations in the flow through the meters.

No mixing chamber is provided here because of the low permissible loss of head, namely, $1\frac{1}{2}$ feet. There are two secondary sedimentation basins, one east of the filter plant and one north, each of which is connected to the influent flume of the filters. The time of reaction and sedimentation, based on capacity, is twelve hours with both basins in service and six hours with one. The water entering the secondary coagulation basins being usually of a turbidity less than 20, little sedimentation takes place. It is not expected that these basins will need cleaning for some years.

The water entering the filter plant is passed through 40 filters, each with a filtering area of 1,400 square feet, of 4,000,000 gallons capacity. The filtering media consist of 30 inches of sand above 12 inches of graded gravel. The effective size of the filter sand as placed in the filters was 0.341 mm., with a uniformity coefficient of 1.81. The effective size has increased to 0.407 mm. and the uniformity coefficient has been reduced to 1.45, due to the coating of the sand grains by material having the following composition:—

	Per cent.
$CaCO_3$	76.00
Al_2 $(YH)_3$ and FE $(OH)_3$	15.00
Mg $(OH)_2$	9.00

Liquid chlorine, in the form of chlorine water, is added after filtration in a chamber in which the filtered water from the three connections to the effluent flume is combined. Two conduits, one a 7-foot ½-inch steel tube, the other a brick and masonry conduit 9 feet high and

11 feet wide, are connected to this chamber. These conduits convey the water to the pumping stations at Bissell's Point and Baden. The bacterial reductions caused by the chlorine were far from satisfactory until a baffle was built in the chamber to aid in mixing the chlorine with the water.

The reduction in bacteria in the water flowing through the steel line is always less than in the water in the brick conduit. Charges of chlorine great enough to give tests for free chlorine in the water in the brick conduit three hours after treatment give no test in the steel line three minutes after. The disappearance and ineffectiveness of the chlorine in the water entering the steel line is attributed to the steel of the line. The Electro Bleaching Gas Company supplies the liquid chlorine, which is measured and controlled by the liquid type meter apparatus, also supplied by this company.

The accompanying operation record for the year ending February 28th, 1918, shows very clearly the kind of water treated, the improvement in the condition of the water for each step of the purification system, the amounts of chemicals used and other details of operation.

WATER WASTE*

By Edward E. Wall
Water Commissioner, St. Louis, Mo.

At this time, when the necessity and the demand for the conservation of all materials and supplies is universal, the presentation of some facts in regard to the waste of water, its value and the wisdom of restrictive measures should be of interest. The normal mind is opposed to the existence and the continuance of waste—and yet, on consideration, no thoughtful man would advocate the absolute elimination of waste. Our whole social and economic system operates with the expectancy of loss from waste, and a large percentage of our activities are devoted to making provision for meeting such losses.

The province of the engineer is pre-eminently the prevention and reduction of waste. He is now, and always has been, continuously striving to prevent loss of energy, and to reduce the waste of materials and labor.

The waste entailed by progress, such as the consignment to the scrap-heap of machinery not worn out, but obsolete,—the wrecking of a perfectly good building in order that upon its site may be erected something better and more useful to mankind,—or the discarding of any useful thing for something more useful, may all be classified as instances of necessary and proper waste. So also may be justified a reasonable amount of waste of time, energy and materials in the pursuits of pleasure and the extravagances of living in general.

The engineer, too, wastes much time and labor on problems that either are unsolvable, or his solutions are presented at untimely moments. Thousands upon thousands of engineers' reports are placed on shelves, never opened; their existence forgotten, although many of them represent thorough and painstaking labor covering periods of many months, and are full of elaborate details pertinent to the case. This sort of waste is, perhaps, largely unavoidable and incidental to the development of the general resources of our country,—and may also be necessary for the education of the engineer.

It may also happen under some conditions that what appears to be waste may be economy: for example, when the Nebraska farmers used corn for fuel because taken for its heat value it was cheaper than coal,—or in those cases where the expense of saving or reclaiming anything of value is more than the value of the thing reclaimed.

The illogical insistence of the people of St. Louis on clinging to a policy requiring the unlimited and unrestricted use of water at a flat rate, together with the heedless disregard of all warnings and protests from Water Department officials, has, many times, taxed the resources and capacity of the waterworks to its utmost limit,—and on a few occasions has brought the city to the verge of a water famine.

From 6 to 212 Gallons

The writer, in May, 1912, measured the consumption in 37 residences containing 212 occupants, finding an average per capita per day of 57 gallons, with a daily minimum of 7, and a maximum of 202 gallons. The same 37 houses in June, 1912, showed an average daily per capita consumption of 54 gallons, minimum 6, and maximum 212 gallons. Average daily consumption for May, 1912, 83.5 m.g.; average daily consumption for June, 1912, 85.5 m.g.

Taking the results of measurements taken in St. Louis, together with reports from observers in other cities, the average quantity of 40 gallons per capita per day would give an ample supply for domestic use.

The quantity of water daily used for public purposes, such as street washing and sprinkling, in public buildings and parks,—and for extinguishing fires, as nearly as can be estimated, should not exceed 12 gallons per capita.

The daily commercial use of water in various cities ranges from 30 to 60 gallons per capita, so that it is safe to estimate 45 gallons as sufficient, while the unavoidable losses of water from the system, such as undiscoverable underground leaks, losses from draining mains for repairs, from leaks and breaks before they can be shut off, from the slip of meters, and water stolen through unrecorded connections and deliberate misrepresentations, will be covered by an allowance of a daily per capita of ten gallons.

A daily consumption of 107 gallons per capita as above divided between domestic, public and commercial uses, including the allowance for unpreventable losses, will not only provide an ample supply for all legitimate uses,—but will still admit of extravagance or waste to a considerable extent, perhaps 20 per cent.

Wanton Waste

The actual average daily per capita consumption for the calendar year 1917 was 133 gallons. This excess of 26 gallons per capita per day represents the actual wanton waste for which there is no justification whatever.

It means that 20,000,000 gallons of water were daily pumped into the mains and deliberately wasted into the sewers and drains without having served any useful purpose. The cost of pumping, purifying and re-pumping this water was not less than $40 per million gallons for operating and maintenance charges alone, or a total value of $800 per day absolutely thrown away, amounting to the total sum of $292,000 for the year 1917.

An examination of the records of the daily consumption for 1917 reveals the fact that water waste is not systematic or uniform, but spasmodic, and erratic, largely fluctuating with the weather. The months of greatest consumption during the summer were June, July, August and September, and in the winter season, February and December.

*Abstracted from paper read before the Engineers' Club of St. Louis.

The days of the heaviest consumptions were those of the highest temperatures in summer, and the lowest in winter.

The rapidly increasing consumption during the last few days of December, 1917, as the temperature gradually lowered, was but the beginning of the period of the longest and heaviest demand ever made on the waterworks. From December 28th to February 8th inclusive, a period of 43 days, the minimum consumption (one day excepted) was 110,600,000, and the maximum, 156,500,000 gallons.

The daily average for the 43 days was 126,400,000 gallons.

It must be remembered that no water could be used during this time for street sprinkling or washing, so that the normal use of water would have been no more than during moderately cold weather in November or March, when the consumption averaged about 92,000,000 gallons. The difference between 92,000,000 and 126,400,000 would represent what may be called the super-waste of water during that period of 43 days, amounting almost to $60,000 at the rate of $40 per million gallons.

10,000,000 Gallons Wasted

The use of 92,000,000 gallons daily under moderate weather conditions is about 120 gallons per capita, meaning that at least 10,000,000 gallons is normally wasted during the periods of most favorable weather, and super-waste occurs at all other times.

The coal burned per million gallons of water pumped by actual weights taken in the boiler rooms averaged 2,800 lbs. This means that over 65 tons of coal were consumed each day for 43 days in pumping water that was allowed to run to waste into the drains and sewers.

This 2,800 tons of coal was consumed at a time when the United States Fuel Administrator was urging economy and restricting coal deliveries to the bare necessities of preferred classes of consumers.

Criminal waste is essentially a vice of civilization. The barbarian may ignorantly or thoughtlessly allow valuable materials to go to waste because of an abundance over and above his uses at the time, or through an inability on his part to foresee his future needs,—but he cannot be accused of knowingly and intentionally destroying things of value to himself, except as war measures to inflict injury on the enemy.

It takes the astute civilized man to deliberately injure his own tribe by consigning car loads of food products to the dump in order that the available supply may be restricted and local prices kept up.

It is the twentieth century civilization that mortgages the future and cheerfully bequeaths the debt to later generations.

House-to-House Inspection

The method of house-to-house inspection for eliminating leaks and waste depends for its efficiency on the frequency of individual inspections,—but it can never be completely effective. It is not in human nature for inspectors to continually perform duties more or less unpleasant,—and to perpetually make visits that are usually unwelcome, yet all the time maintain a high standard of efficiency. It does not generally require many months for an inspector to become somewhat weary of going over the same ground,—to relax his vigilance and to make his visits somewhat perfunctory. We could hardly expect to find, as a rule, for the positions of inspectors at salaries of $75 per month each, men with a keen sense of humor, who would so enjoy the experience of coming in daily contact with many various and sundry specimens of humanity, that the employment would become a pleasure. People do not like to have their houses inspected. In general, they feel that in paying for a water license, they have certainly purchased a right to an extravagant use of water,—if not an absolute privilege to waste it if they desire to do so. In summer they waste many times more water in lawn-sprinkling than is necessary for the growth of the grass and flowers. In extremely cold weather they let the water run to prevent pipes from freezing. No doubt it is more economical for the consumer to waste water than to pay plumber's bills, so long as his premises are assessed at flat rates. The claim may also be set up that the loss to the community, as a whole, would be less from the general wasting of water, than the total expense of repairing all the bursted piping that would result if the water was not allowed to run and wholesale freezing resulted. This claim might be substantiated if the matter ended with the mere comparison of the value of the water wasted and the probable plumbers' bills. Unfortunately the value of the water lost is but a small part of the damage done to the public.

The demoralizing effect of approving waste under certain conditions should be readily apparent, and its consequences could not help but be of additional assistance in forwarding the day on which the water supply would be unequal to the demand.

The owner of a building improperly piped for water, with no adequate facilities for draining the system, may feel that he is not justified financially in removing the old plumbing and installing a new and proper system; he may argue that he is confronted by a condition for which he should not be held responsible; that he is an innocent purchaser of a building erected years ago, presumably in conformity with all building regulations in force at the time; that he would be able to collect no more revenue from his building after reconstructing the plumbing than before; granting that all of his premises are true, he still cannot escape the fact that in protecting his individual interest by wasting water to avoid plumbers' bills, he is trespassing on the rights of his fellows,—and is helping to impose increased taxation on the people of the whole city.

Meters Are Effective

His case would be but little better if his premises were under meter and he was paying for the water wasted, since the indictment against him for sinning against the welfare of the community would still hold. In all probability, if he was paying for the water at meter rates, little or no water would be allowed to run to protect the plumbing.

The only effective and economical method of reducing water waste and leakage to a minimum is through the general installation of meters.

The results attained will be permanent, and the meter will automatically act as an inspector perpetually on the job.

Hon. Frank Cochrane, minister without portfolio in the Union Government, and ex-Minister of Railways and Canals, while in Toronto this week stated that in his opinion the head offices of the Canadian Northern Railway will not be moved from Toronto.

The "Toronto Daily Star" says editorially:—"That the Canadian Northern head office should remain in Toronto under government ownership is not merely a matter of local pride. Toronto is the home of friends of public ownership. Montreal is the home of its enemies. It was from Montreal that a protest was sent to the government against government ownership of the Canadian Northern Railway. The sentiments of Montreal ought to be respected, not insulted by the presence of the headquarters of the government system."

CHAMPLAIN DRY DOCK, QUEBEC*

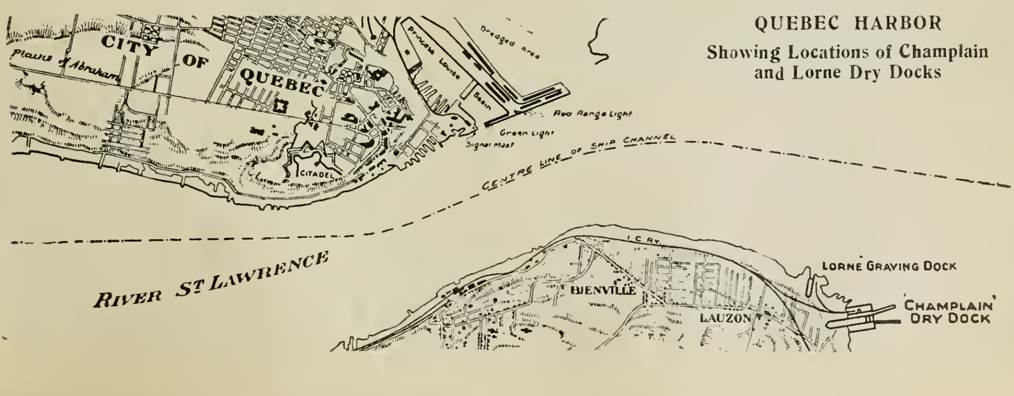
By Ulric Valiquet, M.Can.Soc.C.E.
Supervising Engineer, Department of Public Works, Ottawa

FOR a number of years the River St. Lawrence has been frequented by ocean steamers of such dimensions that they could not be accommodated in the Lorne dry dock, completed in 1886, at Lauzon, in Quebec harbor. In 1906 the Canadian Pacific Railway brought out its steamships "Empress of Britain" and "Empress of Ireland," of 65-ft. beam. The Allan Line steamships "Virginian" and "Victorian" of 60-ft. beam were also placed on the St. Lawrence route in that year. The "Bavarian" of somewhat narrower beam, 59¼-ft., came to Quebec in 1905; thereafter the number of large ships placed on the St. Lawrence traffic increased rapidly, until in 1912 there were 25 vessels that could not have been repaired in the long stretch of the St. Lawrence navigation for want of sufficient dock accommodation, the width of entrance of the present dry dock being only 62 ft. Any of these vessels that required docking had to be repaired temporarily, as well as possible, while afloat, and taken either to Halifax or New York, which, in some cases, was a risky undertaking. The case of the s.s. "Bavarian" was an unfortunate experience in this respect. On November 5th, 1905, she ran aground with a full cargo from Montreal and Quebec, about 40 miles below Quebec, opposite Grosse Isle. Although late in the autumn, she could have been raised and brought to Quebec had there been dock accommodation for her. Her beam was 59¼ ft., but through the accident her sides had bulged out beyond the width of the dry dock entrance. She was raised in the following spring, although further damaged by ice during the winter, and brought on the beach a short distance below the dry dock, where she was sold as scrap. This is the worst case on record in the history of the St. Lawrence navigation. The vessel was only six years old and of a registered tonnage of 10,387 tons.

View of Dock, Looking Toward the St. Lawrence River

In the summer of 1898 the writer was instructed to prepare a report on the practicability of widening the entrance of the Lorne dry dock at Levis, which had been completed in 1886. A plan was submitted, showing the possibility of obtaining an entrance 70 ft. wide, by removing part of the timber sides at the outer end of the dock; increasing the length was also suggested. The first was reported to be inadvisable, as it would greatly disfigure the dock and do away with the convenience of the timber slides; the only feasible way would be to remove and rebuild in another position the eastern side wall, thus depriving the harbor of all dock accommodation for probably two seasons. A new caisson would necessarily have to be provided; the cost would have been considerable. Further, it was considered that a new dry dock would be required in Quebec before many years. The suggestion of lengthening the dock was adopted; the length was increased from 484 to 600 ft.; this consisted merely in moving the circular head, stairways and timber slides 116 ft. further, after excavating the rock to proper width and depth. The work was performed under contract awarded in 1900, for $100,000, and completed in 1901 without interfering with the use of the dock. This dry dock was built by the Quebec Harbor Commissioners under an act, 38 Vict. Cap. 56-1875, by which the issue of

*Paper read before the Montreal and Ottawa branches, Canadian Society of Civil Engineers, April 25th, 1918.

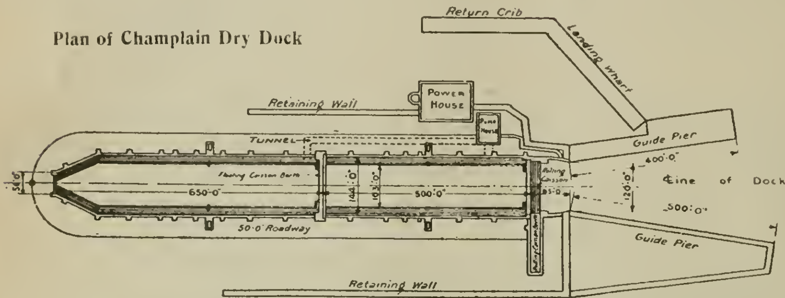


QUEBEC HARBOR
Showing Locations of Champlain and Lorne Dry Docks

bonds was allowed to obtain the necessary amount. The work was started in 1878 and completed in 1886 at a total cost of $921,130. In 1888 the Canadian Government relieved the Quebec Harbor Commission of all obligations to refund the sum expended on the dry dock and in 1890 it was placed upon the control of the Department of Public Works; the writer was then placed in charge.

In 1906 the Quebec Harbor Commissioners urged upon the government the necessity for a large dry dock for Quebec harbor. In the autumn of that year the writer was instructed to make a survey of the locality surrounding the old dry dock and report on the best location. Two sites were examined, but the position to the east of the present dock was considered the most advantageous for three principal reasons. A larger area of land could be acquired. A better foundation could be obtained. The repairing plant of G. T. Davie & Sons could have better access to both the new and old docks. A plan and report were submitted in the early part of 1907; the dock then proposed was 1,000 ft. long with an entrance width of 100 ft. The proposition was not immediately acted upon; the question as to whether the government should build the dock or induce some shipbuilding firm to build it under a subsidy from the government was unsettled. The result of the discussion was the passing at the session of 1910 of an Act to encourage the Construction of Dry Docks.

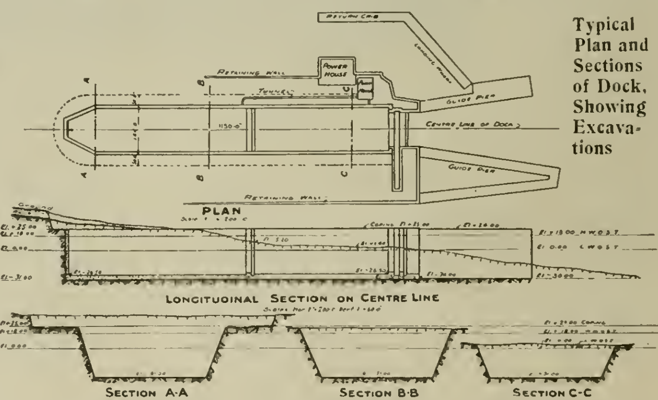
Plan of Champlain Dry Dock



Under this act dry docks were divided into three classes. The first class included dry docks estimated to cost not more than $4,000,000, and capable of receiving and repairing the largest ships of the British navy and of the following dimensions: Clear length on bottom, 900 ft.; clear width of entrance, 100 ft., with depth on sill at high water ordinary spring tides of 35 ft. Floating dry docks of a lifting capacity of 25,000 tons. The second class included dry docks estimated to cost $2,500,000, of the following dimensions: Clear length on bottom, 650 ft.; clear width of entrance, 85 ft.; depth of water on sill at ordinary high water spring tides, 30 ft., if in tidal waters; or 25 ft. on sill, if constructed in non-tidal waters. Floating dry docks of a lifting capacity of 15,000 tons. The third class consisted of dry docks estimated to cost not more than $1,500,000, of the following dimensions: Clear length on bottom, 400 ft.; clear width of entrance, 65 ft.; depth of water on sill at ordinary high water spring tides, 22 ft., if in tidal waters; and 18 ft., if in non-tidal waters. Floating dry docks of a lifting capacity of 3,500 tons. The estimated cost in all cases includes the totally equipped repairing plant, capable of effecting all sorts of repairs, including machine shops and tools, foundry, administration buildings, etc., together with the dock itself, but does not include marine slips or other installation used in the construction of ships.

According to the act, the subsidy on dry docks of the first class is 3½% per annum on the estimated cost for 35 years from the time it has been reported that the dry dock is entirely completed. The subsidy on the second class is 3½% per annum for 25 years from the time of completion. On the third class, the subsidy is 3% for not exceeding 20 years from the time of completion. In all cases the company making the application must furnish plans, with a detailed list of the plant and a complete estimate of the cost. These are revised and corrected, if found advisable; and, upon a report from the chief engineer of the Public Works Department that the works intended to be built are in the public interest, the application is granted upon certain conditions of management and maintenance. The works are to be executed under the superintendence of an officer of the department.

The above act was amended in April, 1912, by making the length of the first class dry docks 1,150 ft., the entrance 110 ft. and the estimated cost $5,500,000. Another amendment was made in May, 1914, by which a subsidy of 4% on the estimated cost is allowed for first class dry docks. The act was further amended in 1917, by which the dimensions of the first class dry docks shall be: length on bottom, 1,150 ft.; width of entrance, 125 ft.; depth on sill at high water spring tides, 38 ft. A subsidy of 4½% on the estimated cost of $5,500,000 is allowed, payable half-yearly for 35 years from the time of completion. By this amendment no bonds or debentures are to be issued until $1,000,000 shall have been expended on the construction of the dry dock.



Typical Plan and Sections of Dock, Showing Excavations

After the passing of the act of 1910, shipbuilding firms were invited to build a dry dock at Lauzon, in Quebec harbor, under the subsidy act of that year. Two companies submitted plans and offered to build under contract

without reference to the subsidy act. In 1912 another company submitted plans for a dry dock to be built on the Quebec side of the harbor, just below the mouth of the St. Charles River, according to the subsidy act, as amended in 1912. Some objection having been made to this location and with no prospect in view for any other applicant, the Public Works Department decided that a dry dock would be built by the government.

In the early part of 1913 the writer was instructed to prepare plans and specifications on which tenders could be called as soon as possible for the construction of the new dry dock, the location being to the eastward of the Davie shipbuilding yard, so that both the old and new dry docks would be easily accessible from the shops. Tenders for the construction of this work were advertised on May 12th,

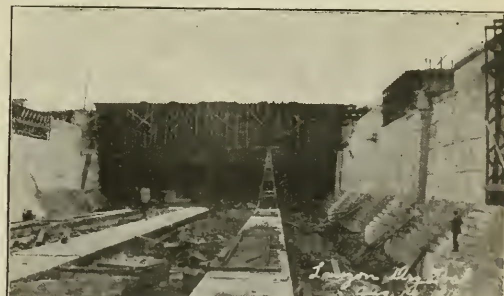
Filling Culvert at Floating Caisson Inner Sill

1913, to be received on June 30th, 1913. The contract was awarded to the lowest tenderers, M. P. & J. T. Davis, and was signed on October 7th, 1913. The new dock was at first intended to be built on a line parallel to the old dry dock, but this was objected to from the point of view of navigation. A commission was appointed in the autumn of 1913 to investigate and find out which direction would best suit the entrance facilities, and it was decided that the central line of the dock should form an angle of 69° with the direction of the old dry dock, or approximately 45° n.e., and it was so laid out. Owing to the limited time available before the calling of tenders, general plans only were prepared, together with an estimate of the cost. The requirements as to details for the machinery and caissons were stated in the specification; the contractors were requested to furnish during construction all detail plans, to be submitted for approval by the department. The dry dock has the following general dimensions: Total length from outer caisson to head wall 1,150 ft., divided into two compartments. Outer part 500 ft., inner part 650 ft.

Width of entrance	120 ft.
Width at coping	144 ft.
Width on floor	105 ft.
Depth on sill at high water, s.t.	40 ft.
Depth on sill at low water, s.t.	22 ft.
Spring tide rise	18 ft.
Coping of side wall above high water, s.t.	7 ft.
Floor at outer end below outer sill	4½ ft.
Slope of floor traversely	1 in 100
Western guide pier	400 ft.
Eastern guide pier	500 ft.
Depth of entrance channel at low tide	30 ft.

Erection of the Concrete Walls

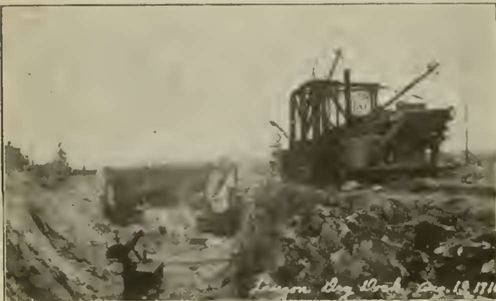
The land expropriated in connection with the construction of the dry dock has a superficial area of 25½ acres, of which 11½ are reclaimed beach land. The outer entrance of the dock is closed with a rolling caisson, the top of which is provided with an automatic folding bridge; a floating caisson closes the inner entrance. This caisson can also be placed to close the outer entrance in cases



Floating Caisson

when repairs are required to be made to the rolling caisson. Three main centrifugal pumps, each of 63,000-gallon-a-minute capacity, are used to empty the dock; two pumps of 6,000 gallons a minute each are used to keep the dock dry. All pumps are run by electric power. Eight boilers of a total capacity of 3,600 h.p. furnish the steam at 200 lbs. pressure to run the three direct current turbo generators of 1,500, 750 and 300 kilowatts respectively, which furnish the current at 550 volts to run the pump and other motors. A direct current generator of 100 kilowatts

at 220 volts, driven by a steam engine, will furnish the current for the lamps around the dock and in the buildings. There are 24 lamps of 500 watts, hung from poles around the dock. The poles are made of gas pipe, with the lower end set into sockets fitted with electric connections, and made removable in case of necessity. All electric wiring for lamps and motors outside of the buildings is placed underground. The approximate quantities



The Rock Excavation was Heavy

of the materials in the principal items entering into the construction are:

Rock excavation above and below coping	342,000 cu. yds.
Submarine rock excavation in channel ..	65,000 cu. yds.
Dredging entrance channel	530,000 cu. yds.
Concrete	100,000 cu. yds.
Granite steps, altars and quoins	140,000 cu. ft.
Steel beams, reinforcing bars and manhole covers	150,000 lbs.
Cast iron for roller casings and sluice valves	125 tons
Cast steel for caisson roller	65 tons
Gun metal for caisson roller and valves.	4,500 lbs.
Cast iron in keel blocks and bollards	990 tons
Forged steel spindles for rollers	11,000 lbs.
Bricks for chimney and flues	345,000
Fire bricks	125,000
Cribwork in approach piers	63,300 cu. yds.
Concrete in approach piers	13,300 cu. yds.
Steel in rolling caisson	930 tons
Total weight in rolling caisson and machinery	1,125 tons
Steel in floating caisson	960 tons

The work was started in May, 1914. The concrete retaining walls on each side of the dock, specified to be built from the natural rock surface to elevation + 24 and intended to prevent seepage through the filling, were completed during the season's work, as well as the cofferdam between the outer ends of these walls. Rock drilling in the prism of the dock was also carried on in the part not affected by tides. The largest part of the drilling was done by two well drillers, the holes being sunk down to grade and plugged for future blasting. The average depth of perforation for each drill was about 80 ft. a day, although as much as 130 ft. was done occasionally. Ten or twelve ordinary steam drills were also used on the work. The rock consisted of hard shale, irregularly stratified, at an angle of about 45°. Considerable rock slides occurred on the west side of the cut, which necessitated a much larger quantity of concrete for the dock wall on that side, also the use of rock bolts, to prevent the sliding tendency of this wall. Steam shovels and dump cars were used to remove the blasted rock, which was used for filling, wherever required, on the government property.

The cofferdam was built of timber cribwork, 20 ft. wide, sunk in an average depth of 1 ft. of water, at low tide, and built to the elevation of 3 ft. above high tide; a layer of concrete was deposited along the bottom of the outer face and this face was sheathed with plank. The floor and walls of the dock are built of concrete, the mixture being 1 : 3 : 5. All exposed faces are finished with a fine concrete of 1 : 2 : 4 mixture for a thickness of 6 ins. The concrete for the walls and the floor was cast in alternate sections of approximately 30 ft., with expansion joints. All the cement used was subjected to a laboratory test; apart from other requirements the tensile strength was required to be 600 lbs. a square inch after 27 days immersion, for neat briquettes, and 275 lbs. a square inch for 1 : 3 mixture.

The steps at the toe of the walls are built of granite, with treads and risers of 12 ins.; the altars are 2½ ft. wide and consist of granite 12 ins. thick, tailing 9 ins. into the concrete. The caisson stops of both entrances and all culvert openings are built of granite. The floor is 5 ft. thick and finished level from end to end; the sides slope down 6 ins. to the side gutters. The floor is provided with three strips of granite slabs, 18 ins. thick, intended to receive the cast iron keel and bilge blocks. The middle strip is 10 ft. wide and level; the side strips are 9 ft. wide. In order to prevent the possibility of hydrostatic pressure under the floor and behind the side walls, a system of drains is provided, that will take the seepage water to the sumps. There are 12 stairways from the top of the walls to the floor of the dock, two at each end of the two compartments and two half-way between the ends of each compartment. Four timber slides, built of granite slabs, 18 ins. thick, are provided alongside the last set of stairways. There are also 8 ladders, 4 on each side of the dock, that may be used to reach the floor. These are built with galvanized iron gas pipe, and set in recesses in the walls. The coping of the walls stands at elevation + 25, or 7 ft. above high tide. They are provided with

Excavation for Caisson Chamber

the ordinary cast iron bollards, set in concrete blocks, 60 ft. apart. There are 9 electrically driven capstans with 15 h.p. motors, 4 on each side of the dock and one at the head.

The keel blocks are each built of three pieces of castings; the middle piece being wedge-shaped so that it may be knocked out and the block removed from under a ship, when in the way of repair work; the upper part of the top piece of casting is provided with a piece of white oak tenoned into the casting. All rubbing faces are planed true and smooth. The keel blocks are 4 ft. 4 ins. long

and 2¼ ft. high. On top of these are placed temporary hard-wood timber blocks to obtain the required height above the floor. It had been intended to build bilge blocks so arranged as to slide under the bilge of vessels. However, this was objected to by the British Admiralty, which insists on having all blocks made of the same pattern, so as to enable building a bed that will conform to the bottom of the vessel.

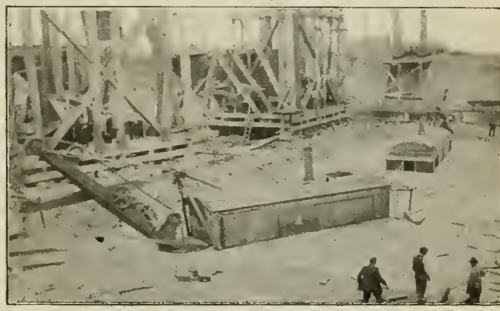
Caissons

The outer entrance is closed by a rolling caisson built of steel and operated by an electric motor of 125 h.p.; the bottom is provided with two heavy scantlings of steel, resting on flanged rollers, 3 ft. in diameter, placed at 8 ft. centres. These are made of cast steel and bored to receive bronze bushings. The forged steel spindles, 4 ins. in diameter, are also provided with bronze sleeves. The cast iron casings, containing the rollers, are set in the concrete altars, on each side of the caisson berth and chamber. At an elevation of 15¾ ft. above the sill of the dock the rolling caisson is provided with 6 culverts, 42 ins. in diameter, closed by sluice valves that are operated from the upper deck by a 15-h.p. electric motor, driving a longitudinal shaft provided with the necessary gearing; and, by means of clutches, any one or all of the valves may be worked. The culverts are used for flooding the dock. The caisson is divided horizontally by a water-tight deck at the elevation of 23½ ft. above the bottom, forming the ballast and tidal chambers. As the tide rises the sea water comes on this deck through valves in the outer face of the caisson, which are kept constantly open during the summer to prevent the caisson from floating. A sufficient quantity of ballast is provided, so that the total weight of the structure resting on the rollers is approximately 150 tons. During the winter, when the dock is not in operation, the lower or ballast chamber of the caisson is filled with water, which is kept from freezing by a constant jet of steam. The tidal chamber is then kept dry by closing the valves. The caisson is closed and opened with heavy chains, supported on altars on each side of the caisson recess, and passing over pulleys worked by worm gears connected with the motor. The top of the caisson is provided with a folding bridge for light traffic across the dock; as soon as the caisson starts to open, the apron and railings of the bridge are automatically lowered to allow them to pass under the flooring over the caisson recess. The middle entrance of the dock is closed by an ordinary floating or ship caisson. When in place, the deck is used as a bridge across the dock. This caisson may also be used to close the outer entrance by placing it immediately outside the rolling caisson, where the necessary stop is provided for it. This, however, will be necessary only in cases of repairs being required to the submerged parts of the rolling caisson. These caissons were built by the Dominion Bridge Company, under a sub-contract.

First Drilling in Front of Temporary Cofferdam

Boilers and Electric Power

Six water tube boilers of 500 h.p. and two of 300 h.p. furnish steam at 200 lbs. pressure to produce electric current. The boilers are provided with automatic stokers, ash and coal conveyers. The coal is unloaded from cars into a coal crusher run by an electric motor, and elevated to a hopper of 500 tons capacity, over the front of the boilers. Water heaters are provided, but the steam is not superheated; one of the small boilers will be constantly under steam pressure to run the drainage pumps and the lighting dynamo. The electric power consists of 3 direct current turbo-generators of 550 volts, one of 1,500 kilowatts, one of 750 and one of 300 kilowatts. The steam turbines are of the Curtis condensing type, built by the General Electric Co. In the large unit the turbine runs at 3,600 r.p.m. It is geared down to 360 revolutions for the generator; the second is geared from 5,000 to 750; the third is geared from 5,000 to 900 r.p.m. A 100-kilowatt generator driven by a high-speed direct connected steam engine, furnishes the current for lighting purposes. This power installation is more than ample for all the machinery connected with the running of the dock proper. It is, however, anticipated that the whole of it will be used when large repairing and shipbuilding shops are in operation together with the pumping of the dock.



Start of Excavation Near the Temporary Cofferdam. Shovels Drowned by Infiltration

This electric installation has been criticized, on the ground that the large expenditure is not justified when electric current is available from private companies in the vicinity of Quebec. When the electric installation was proposed by the writer the idea in view was that no company would be interested or willing to furnish over 3,000 h.p. at any time of the day or night for the short period of about 50 hours in the year without interfering seriously with their general service. It had also been ascertained by personal visits to five of the principal U.S. Government navy yards that each of them has provided its own electric power for pumping their dry docks. Out of five, only one had installed alternating current machinery. It has developed since that the only electric company that could furnish the power current is not willing to entertain the proposition unless at a much greater cost to the government than the private installation can be run, including the interest on the outlay, which is approximately $240,000.

Pumps

The dock is emptied by three main pumps of the horizontal centrifugal type, each having a capacity of 63,000 gallons a minute. The bronze shafts are connected to the armature shafts of 800 h.p. motors, running at 750 revolutions a minute. The motors are built to stand an overload of 25% for two hours; the total lift will very rarely be more than 33 ft. The suction and discharge pipes are 48 ins.; the water is discharged into a chamber provided with non-return valves, and to a culvert through the entrance wall outside of the caisson. The main pumps are guaranteed by the builders to deliver 63,000 gallons a minute against a total head of 25 ft. At the time of writing, these pumps have not been tested as to efficiency. Two auxiliary pumps, each of 6,000 gallons a minute capacity, driven by electric motors of 125 h.p., will take care of leakages and seepage; these pumps will also help while the dock is being pumped. The pumps were manufactured by the Allis-Chalmers Co.

The time occupied in emptying the dock will vary according to the height of tide when the pumps are started and the size of the vessel being docked. At high water of spring tides the dock contains over 38,000,000 gallons of water. This quantity of water, however, will very rarely, if ever, exist, when pumping is started. It is estimated that the average time for pumping out the dock will be about 2½ hours.

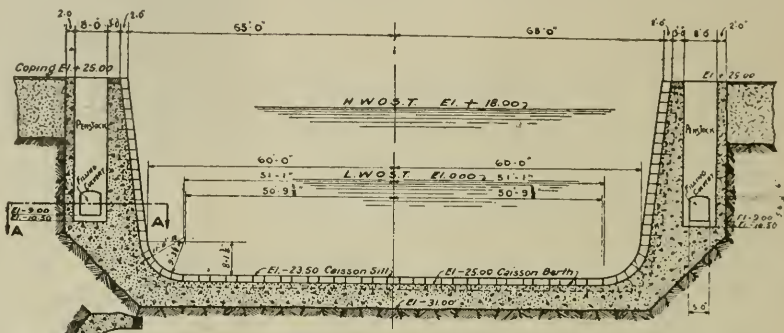
Underground culverts 9 x 10 ft. convey the water from the sumps in each compartment of the dock to the pumps; these culverts are provided with sluice gates so as to permit of operating each compartment separately. The gates are operated from coping-level by 15 h.p. electric motors. The pressure against the gates may at times be due to a head of 50 ft. of water. From the non-return valve chamber the discharge culvert is 7 x 12 ft.; it is also provided with a sluice gate. The capacity of discharge of this culvert was obtained from Chezy's formula $V = c\sqrt{rs}$, c being obtained from Kutter's formula. Under a head of 4 ins. the capacity will be ample to take care of the output of the pumps when discharging in open air.

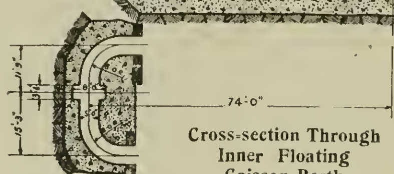
The dock is filled through the 6 culverts in the outer caisson, each having a sectional area of 9 sq. ft., also 2 culverts, one in each side wall of a sectional area of 30 ft., the valves of which are operated by electric power. These culverts are made exceptionally large, due to the fact that each may only be partially opened until the water in the dock has reached the centre of the culvert opening, to prevent the heavy current that would result from a large opening from disturbing the beds prepared to receive a vessel; further, as the head between the outer and inner levels of water decreases, the valves are fully opened, thus obtaining a large flow. The time required to fill the dock may at times be as much as four hours. The middle entrance is similarly provided with filling culverts as the outer entrance.

In order to obtain sea water by gravity for the purpose of washing the floor of the dock, 6-in. pipes were laid in the concrete side walls of the dock, at an elevation of 2 ft. above low tide; each pipe has 6 hose connections and valves at the face of the walls, where 50-ft. lengths of 2½-in. hose may be attached for the purpose. The water is available within one hour of extreme low time. Washing the floor is necessary owing to the sediment accumulated while the dock is flooded.

Guide Piers

The western guide pier is 400 ft. long and 75 ft. wide; the one on the eastern side is 500 ft. long, 75 ft. wide at the outer and 200 ft. wide at the inner end. Each is built of two lines of 12 x 12 timber cribwork substructure up to 6 ft. above low water, spring tides; the outer face of each line of cribwork is built close, and sheathed vertically with 10-in. hardwood planks. The cribs facing on the channel were sunk in a depth of 30 ft. at low water, spring tides; those on the eastern side of the east pier were sunk on the natural surface of the rock. Those on the western side of the west pier, as well as those for the landing pier, were sunk in a depth of 24 ft. at low tide. From the elevation of 6 ft. above low tide the superstructure consists of mass concrete walls, stepped at the back and filled between with excavated material. The railway spur track from the Intercolonial Railway will be extended to the end of the western pier. These piers are intended to be used, when necessary, for unloading parts of cargoes from vessels to be docked. The entrance channel has a depth of 30 ft. at low water, spring tides. The landing pier on the west side of the entrance is intended for unloading the dock supply of coal, when delivered by water.





SECTION AT A-A

Cross-section Through Inner Floating Caisson Berth

Buildings

The power house is 120 x 100 ft., divided by a brick wall into two rooms, 120 x 50 ft., one being the boiler room and the other the generator room; the walls are solid brick, built on concrete foundation; the roof is built of reinforced concrete slabs, supported by steel I-beams, which were procured from the unused steel of the first Quebec Bridge. The building is provided with extra large windows with steel frames. Skylights and ventilators are also provided. The floor is concrete, overlaid with red tiles; and the lower part of the interior walls for the generator room is finished with a white tile wainscotting, 6 ft. high. Each room is furnished with water closets and wash basins; the water is obtained from the Lauzon village aqueduct. A special pump in case of fire and the

necessary hose are provided. The generator room has an overhead travelling crane of 15 tons capacity. The lifting is done by motor; the travelling gear is worked by hand.

The pump house is 70 x 47 ft., with foundation walls of concrete, over which solid brick walls are built. The floor is at an elevation of 16 ft. below low water, spring tides, or 41 ft. below coping. It is finished with red tiles. The interior walls up to coping level are finished with white tiles. The pump house is also provided with an overhead travelling crane of 10 tons capacity. The chimney is 180 ft. high, built of brick, with an inner shell of fire brick 100 ft. high. There is an air space of 6 ins. between the inner and outer shells; the inside diameter is 11 ft.; the top consists of a cast-iron cap; four lightning rods, well grounded, are provided to protect the chimney.

The length of the dock was decided on not merely in anticipation of vessels of, say, 900 ft. or over being employed on the St. Lawrence trade, which may not happen for a great number of years, but owing to the great number of applications received every fall from owners of moderate sized vessels for accommodation during the winter, so that repairs may be done at cheaper rates, and the boats be ready for traffic as soon as navigation opens.

The dock is not yet quite completed: small portions of the floor and walls at the head remain to be finished; the boilers, machinery and pumps, although in working condition, require some final adjustment before they are tested and accepted;—the rolling caisson was operated in November, 1917,—the contractors' floating plant was docked and the dock was pumped out. It is fully expected that everything will be entirely completed during July.

The several classes of works in connection with the construction of the dock have been accomplished in a thorough manner both in regard to materials furnished and workmanship; several minor changes which were found to be advantageous were made during construction. The contractors, in all cases, have shown their willingness to give satisfaction in every way irrespective of cost. It must be noted that the works were started shortly before the war and continued without interruption, except in winter, in spite of increased cost of materials and labor. The time required for the construction of the dock is somewhat over four years. It must, however, be remembered that the working season is only six months in each year,—concrete works have to be suspended during the first days of November and cannot be resumed until the beginning of May. The total cost of the works under contract will be approximately $3,365,000. The works have been carried on by the Public Works Department, with E. D. Lafleur as chief engineer,—the writer as superintending engineer, and J. K. Laflamme as resident engineer,—S. Fortin, steel structural engineer, has had the approval of plans submitted for the steel structures. The contractors are M. P. & J. T. Davis, and S. Woodard is their superintending engineer.

According to the annual report of the Department of Railways and Canals for the year ended March 31st, 1917, the government railways in operation and their mileage were as follows:—

Intercolonial	1,518.39
Prince Edward Island Railway	275.20
National Transcontinental Railway	1,811.28
Grand Trunk Pacific Railway	191.75
New Brunswick and Prince Edward Island Railway	36.05
International Railway of New Brunswick	111.30
St. John and Quebec Railway, operated but not owned	119.87

DOMINION POWER BOARD

FOLLOWING the discussions of the House a few weeks ago respecting the fuel situation in the Dominion, the government has taken prompt and constructive action to provide for the future needs of the country, insofar as fuel and power are concerned. Recognizing that in the various government departments there are officials who have become expert in various phases of the fuel and power problems of the Dominion, the government has decided to take advantage of such immediately available advice and assistance with a view to co-ordinating all the government activities respecting investigation and administration of fuel and power matters. The Honorable Arthur Meighen, Minister of the Interior, is the chairman of the board, which will be known as the Dominion Power Board. The other members are: Arthur St. Laurent, assistant deputy minister, Department of Public Works; C. N. Monsarrat, consulting engineer of the Department of Railways and Canals; W. J. Stewart, consulting engineer to the Department of External Affairs regarding international waters; John Murphy, electrical engineer to the Dominion Railway Commission; H. G. Acres, chief hydraulic engineer, Hydro-Electric Power Commission of Ontario; O. Higman, chief electrical engineer, Department of Inland Revenue; D. B. Dowling, geologist, Department of Mines; B. F. Haanel, chief engineer, fuel testing division, Department of Mines; J. B. Challies, chief engineer and superintendent, Dominion Water Power Branch, Department of the Interior.

PURE WATER ALWAYS PAYS

DAMAGES amounting to $50,462 have been granted by the courts to the members of the Detroit commandery No. 1, Knights Templar, and their families for sickness caused by drinking polluted water from the Sault Ste. Marie River while on a cruise in June, 1915, on the steamship "South American." After the steamer, which had been chartered by the knights for a cruise to Huffton, had returned to Detroit, an epidemic of typhoid broke out among the passengers. The courts held that the steamship company was responsible for the illness.

The steamship "Faith," the largest ocean-going concrete vessel in the world, arrived in a Canadian Pacific port last week on her maiden trip from San Francisco.

The name of the National Iron Works, Ltd., of Toronto, has been changed to the National Iron Corporation, Ltd. There is no change, however, in the directors or personnel of the company.

According to the franchise of the British Columbia Electric Railway Company, the city of Vancouver may purchase its property and lands, providing it signifies its intention of doing so not later than August of this year. The subject was discussed at a recent meeting of the Vancouver Board of Trade, and a letter addressed to the mayor of the city calling attention to this fact and placing the services of the board at the disposal of the city. The company owns and operates 334 miles of electric railway. It is an English limited company, incorporated in 1897, and carries on under powers conferred by acts of the parliament of British Columbia, a well-established electric railway, lighting and power business in Vancouver, North Vancouver, South Vancouver, Point Grey, New Westminster, Victoria and other adjoining municipalities. Most of the company's securities are held in England. The total share capital issued is £4,320,000, in addition to which there is over £1,800,000 of debentures and debenture stock. This is the largest public utility corporation in the province.

RECOMMENDED CHANGES IN CLAY AND CEMENT SEWER PIPE SPECIFICATIONS

CHANGES in the tentative specifications for cement sewer pipe and also for clay sewer pipe have been recommended by the committee on sewer pipe of the American Society for Testing Materials. Dr. Rudolph Hering, consulting engineer, of New York City, is the chairman of the committee.

The committee recommends that in the case of clay sewer pipe the values in Table 3, "Dimensions," of the society's specifications, be changed as follows:—

Changes in Clay Pipe Specifications

1. *Table III.*, "*Dimensions.*"—Change the values in the fourth column on "Depth of Hub" to read as follows (the figures in brackets indicate present values to be revised:

Internal Diameter, in.	Depth of Socket, in.	
6		2
8		2½
10		2½
12	[3]	2½
15	[3]	2½
18		3
21	[3½]	3
24	[3½]	3
27	[4]	3½
30	[4½]	3½
33	[5]	4
36	[5]	4
39	[5]	4
42	[5]	4

2. *Section 32.*—Change to read as follows by the insertion of the italicized words:

"The ends of the pipes shall be square with their longitudinal axis, *except as provided in Table IV.*"

3. *Section 33 (b).*—Change the first sentence to read as follows by the insertion of the italicized figure and the omission of the figure in brackets:

"Curves shall be at angles of 90, 45, 22½ [11¼] deg., as required."

4. *Table IV.*, "*Permissible Variations in Dimensions.*" After the second column, insert a new column headed "Lengths of Two Opposite Sides, in." as follows:

Normal Size, in.	Limits of Permissible Variation in Lengths of Two Opposite Sides, in.
6	⅛
8	⅛
10	⅛
12	⅛
15	⅛
18	3/16
21	3/16
24	¼
27	¼
30	¼
33	⅜
36	⅜
39	⅜
42	⅜

5. Substitute the word "socket" for "hub" wherever used in the specifications.

Changes in Cement Sewer Pipe Specifications

1. *Section 31 (b).*—Change the first sentence to read as follows by the insertion of the italicized figure and the omission of the figure in brackets:

"Curves shall be at angles of 90, 45, 22½ [11¼] deg., as required."

2. *Table III.*, "*Dimensions.*"—Change the table to read as follows by the insertion of a new column headed "Normal Annular Space" and by replacing the matter in brackets by the words and figures indicated:

Table III.—Dimensions of Cement-Concrete Sewer Pipe

Internal Diameter, in.	Laying Length, ft.	Diameter at Inside of [Hub], *Socket*, in.	*Normal Annular Space, in.*	Depth of [Hub], *Socket*, in.	Taper of [Hub] *Socket*.	Minimum Thickness of Barrel, in
6	2	[8½] 8¼	½	2	1 : 20	⅝
8	2, 2½, 3	[10⅞] 11	⅝	[2½] 2¼	1 : 20	[⅞] ¾
10	2, 2½, 3	13¼	⅝	2½	1 : 20	[1] ⅞
12	2, 2½, 3	[15½] 15⅝	⅝	[3] 2½	1 : 20	[1 3/16] 1
15	2, 2½, 3	19¼	⅝	[3] 2½	1 : 20	[1½] 1¼
18	2, 2½, 3	22¾	⅝	[3] 2¾	1 : 20	[1¾] 1½
21	2, 2½, 3	26½	¾	[3½] 2¾	1 : 20	[2] 1¾
24	2, 2½, 3	30¼	¾	[3½] 3	1 : 20	[2⅜] 2⅛
27	3	34	⅞	[4] 3¼	1 : 20	[2⅝] 2¼
30	3	38	1	[4½] 3½	1 : 20	[3] 2½
33	3	41½	1	[5] 4	1 : 20	[3¼] 2¾
36	3	[45¾] 45½	1¼	[5] 4	1 : 20	[3½] 3
39	3	[49¼] 49	1¼	[5] 4	1 : 20	[3¾] 3¼
42	3	[53¼] 53	1½	[5] 4	1 : 20	[4] 3½

[1] When pipes are furnished having an increase in thickness over that given in last column, the diameter of [hub] *socket* shall be increased by an amount equal to twice the increase of thickness of barrel.

3. *Table IV.*, "*Permissible Variations in Dimensions.*" Change the values in the third and fourth columns, on "Spigot" and "Hub," to read as follows (the figures in brackets indicate the present values to be revised):

Normal size, in.	Limits of Permissible Variation in Internal Diameter, in. Spigot ±.		Socket ±	
6		3/16	[¼]	3/16
8		¼	[5/16]	¼
10		¼	[5/16]	¼
12	[5/16]	¼	[⅜]	¼
15	[5/16]	¼	[⅜]	¼
18	[⅜]	¼	[7/16]	¼
21	[7/16]	5/16	[½]	5/16
24	[½]	5/16	[9/16]	5/16
27	[⅝]	5/16	[11/16]	5/16
30	[⅝]	⅜	[11/16]	⅜
33	[¾]	⅜	[13/16]	⅜
36	[¾]	½	[13/16]	½
39	[¾]	½	[13/16]	½
42	[¾]	½	[13/16]	½

4. Substitute the word "socket" for "hub" wherever used in the specifications.

Trent Canal, from Lake Ontario to Lake Simcoe, was formally opened last week. The Minister of Railways and Canals and members of his party were tendered a banquet at the Empress Hotel, Peterborough. Among those who accompanied the Minister on the trip were C. N. Monsarrat, chief engineer, Quebec Bridge Commission; W. A. Howden, chief engineer of Railways and Canals; E. Guss Porter, K.C., M.P.; and Chief Engineer Phillips, of the Rideau Canal.

REINFORCED CONCRETE SHIPS*

By A. Alban H. Scott
Vice-President, Society of Architects

STEEL shipbuilders look upon reinforced concrete as a very complex matter, chiefly owing to the large number of small rods and the overlap required to get continuity, but in comparing the form of jointing in reinforced concrete work to the riveting in steel ships and the caulking required one would perhaps be justified in thinking that it might be impossible to get a comparatively water-tight ship with steel plates, when it is considered that for a ship to, say, 1,000 tons D.W. for the hull alone there would be approximately 2,500 separate sheets and angles of steel used and somewhere in the neighborhood of 110,000 rivets.

The approximate number of bars in a reinforced concrete vessel (same D.W.) would be 52,000.

Testing of Materials is Important

The testing of materials for reinforced concrete ships is one of extreme importance, and the Concrete Institute's report on this subject should be carefully studied. The whole of this report is applicable to shipwork, except that the maximum size of the coarse material requires, in the opinion of the writer, to be reduced to ⅜ in.

Additional tests are desirable as to the impermeability of concrete, and also as resistance to shock.

In several references to reinforced concrete ships one notices the phrase that "concrete is poured in," and in the opinion of the writer the loose application of this term should be combated. To obtain the best results, concrete should be *placed* into position as dry as possible, and after the concrete has been so placed, and sprinkled with water the result is a material much stronger and much more waterproof than a wet, sloppy mixture, or even a mixture which might be termed plastic; for this reason one would much sooner adopt the method of elevating the practically dry, mixed material in preference to delivery by gravitation.

Materials Required

A good deal of discussion has been taking place as to the suitability of various sites for the construction of reinforced concrete vessels. It is necessary to consider first the materials involved. If we take a boat of, say, 1,000 tons D.W., we find we shall require approximately 40 tons of clean, fresh water, free from injurious foreign matter, 564 tons of aggregate, 234 tons of sand, 125 tons of cement, 160 tons of steel, and 138 tons of material for equipment in the way of machinery, etc. It is clear, therefore, that the combined weight of the sand and aggregate is 66 per cent. of the total required, including equipment. It would consequently appear desirable, so as to save the cost of freightage and the difficulties of transport, that waterways for these shipyards should be looked for in the neighborhood of suitable stone quarries, where crushing plants could be put down and trolley-ways or rope-ways for transporting the material from the quarry to the shipyard could be arranged. It is also possible that cement could be obtained in the immediate district. If concrete in a relatively plastic condition be finally chosen such a method of transport from the quarries to the vessel obviously suggests that the material should be lifted above the ships, and after being mixed at a convenient level the concrete should be transferred by gravity to each particular vessel and part of the vessel requiring concrete at the moment. This method, however, the author suggests, requires too great a percentage of water.

With this new form of construction for vessels the temptation to depart from true ship lines must be resisted. For many years investigations have been carried on to ascertain the lines which give the least resistance to a ship passing through water; and because a different material is proposed to be used for certain boats it is submitted a great mistake would be made by departing from proper and regulated lines of the ship in the expectation of securing economies in construction in reinforced concrete. Safety and efficiency in running must be the first considerations. To depart from proper ship lines would involve extra expenditure on the running costs, which would quickly neutralize any saving on the capital outlay of the ship when constructed. No doubt it would be found that if five or six boats were built with the same set of centering there would be no additional cost by having what is known as "circular circular work." It has been stated that it is more difficult to get the reinforcement into position by following the true ship lines than if straight lines are adopted. The obvious reply to this is, that it is more difficult to construct upper stories to a building than lower stories, therefore we won't have any upper stories, or if it is more difficult to provide for hatchways, leave them out.

"Flour" Should Be Eliminated

The importance of testing each individual material used in reinforced concrete cannot be too strongly emphasized.

The following results of tests might be of interest:—

By kind permission of the publishers the following extracts are given from my previously published book, "Reinforced Concrete in Practice."

"It is important that 'flour' should be eliminated from the sand. The actual size of the grains of sand in the concrete has a material effect on the strength of the work. Table No. 15 indicates the amount of surface to be covered by the cement."

	Materials passing through a mesh of the following diameters.		Approximate total surface area of the particles contained in each cubic foot of material.
	Inches.		Square inches.
Sand.	0.0066	Should not be used for R.C. work.	1,530,000
	0.013		792,000
	0.025	....	412,000
	0.04	....	268,000
	0.06	....	194,000
	0.13	....	98,000
	0.25	....	45,000
Aggregate	0.37	....	28,000
or coarse	0.5	....	21,000
material.	0.62	....	16,000
	0.75	....	13,600

These areas are taken on the assumption that the grains have smooth and even surfaces, and no allowance has been made for irregularities of any description; they should therefore be considered as the minimum area.

Grading the Material

The amount of voids in the aggregate and sand when mixed renders it necessary to exercise the greatest care in grading the material. To ensure good compact concrete the voids should be reduced to the lowest percentage com-

*Abstracted from paper read before the Concrete Institute, May 9th, 1918.

patible with the elimination of "flour." The following table is the average of three determinations:—

	Percentage of voids.
Passing ¾-in. and retained on ⅝-in.	48.2
⅝-in. to ½-in.	44.5
½-in. to ⅜-in.	43.4
⅜-in. to ¼-in.	42.9
¼-in. to ⅛-in.	39.8
⅛-in. to 1/16-in.	39.0
1/16-in. to 1/32-in.	35.5
1/32-in. to 1/50-in.	34.5
Pit sand all passing ¼-in., retained on 1/50-in.	30.2 to 23.3
Broken granite passing ⅜-in., and retained on ¼-in	47.6 32.3
10 parts broken granite, all passing ¾-in. and retained on ¼-in., and 5 parts Leighton Buzzard sand, all passing ¼-in.	22.6

PALMERSTON WATERWORKS*

By A. E. Davison
Manager Municipal Department, Ontario Hydro-Electric Power Commission

ORIGINALLY the town of Palmerston, Ontario, obtained its water supply by means of air-lift pumping from two 8-inch wells, but the quantity thus raised became inadequate to serve the growing needs and during the first half of 1916, the local authorities consulted the Hydro-Electric Power Commission of Ontario on the subject of increasing the supply.

Several schemes were thought of, the two chief ones being as follows:—

1. To install a deep well pump.
2. To install a centrifugal pump.

The first was abandoned, since it was found that in order to obtain the 300 or 400 Imperial gallons per minute required, a 12-inch well would be necessary, and this meant boring a new well, which it was desired to avoid.

The second presented the difficulty that careful estimates based on the data at hand showed that the water level, when the required quantity of water was being pumped, would be about 40 feet below the surface of the ground, and as a centrifugal pump does not work satisfactorily with more than about 18 feet of suction, the use of such a pump would involve the sinking of a caisson around the well large enough to accommodate the pump and motor.

It appeared, however, that this scheme might be feasible, although it was realized that trouble would be encountered owing to the presence of quicksand some distance below ground level.

Finally a recommendation was made to the local authorities that a caisson around one of the wells be sunk about 30 feet deep and 8 feet in diameter and that in it should be suspended a vertical pump and motor, the pump to be at the bottom of the caisson and the motor near the top.

The local Water and Light Commission having given the Hydro-Electric Power Commission authority to proceed on this basis, plans and specifications covering the requirements were issued and tenders were obtained, the contract for the pump and motor going to the Canadian Fairbanks-Morse Company, Limited. The pumping equipment comprised the following:—

(a) One 4-inch, 2-stage, vertical centrifugal pump, capable of delivering 400 Imperial gallons per minute of clean, fresh water against a total head of 125 feet, with a guaranteed efficiency of 55 per cent., the speed being 1,435 revolutions per minute.

(b) One 30-h.p., 3-phase, 25-cycle, 550-volt, vertical, squirrel-cage, moisture-proof, induction motor, having a guaranteed efficiency of 87 per cent. at full load.

(c) Vertical steel framework, steady bearings, ball-thrust bearings, etc.

The work of excavating and making the caisson was undertaken by the town with the advice of the commission, a wood lining at first being tried; owing, however, to difficulties due to quicksand and the presence of some large boulders, as the work proceeded downwards the commission's engineers recommended a steel caisson, specifications for which were issued. This steel caisson was purchased from the National Equipment Company, of Toronto, and as soon as it was received the work was continued to a successful conclusion, though not without further difficulties due to quicksand being met.

The pump and motor, having passed the tests at the maker's works, were shortly afterwards installed and started up. A few minor troubles were experienced at that stage but were very soon set right and the equipment has now been operating quite satisfactorily since the first two or three weeks after installation—a period of some twelve months.

A small housing has been built over the caisson and electric lamps illuminate the interior. In order to install this equipment, the air-lift pumping plant at one of the wells has, of course, been dismantled, but the other remains intact for use in emergencies.

A very slight seepage of water into the caisson takes place, and to deal with this, a small gear pump has been installed; but it is only operated infrequently.

The entire cost of the work, including the surmounting of the troubles experienced with the quicksand, was approximately \$3,400. As showing the financial advantage of having carried out this work, it may be said that information received from Palmerston indicates that whereas formerly the cost of coal for pumping was some 720 tons per annum at \$4.45 per ton (\$3,204), the cost for electric current is now about \$876 plus 12 tons of coal at \$10.50 (this price for coal seems high but does not seriously affect the saving of \$2,200 shown if reduced to the figure used below, *viz.*, \$7) which represents a saving of \$2,200 per annum in operation alone. It may safely be added that there is no increase in any other costs, such as labor or repairs, tending to offset this favorable result.

The saving as above does not represent the true state of affairs for 1917, since, had the old method of pumping been in use, the gain would have been about as follows:—

720 tons of coal at \$7 per ton = \$5,040; while for electricity, assuming coal at the same price (*viz.*, \$7 per ton) the cost would be \$876 plus \$84 = \$960, showing a saving of over \$4,000 for the year.

*From the Bulletin of the Ontario Hydro-Electric Power Commission.

Among the Canadian patents recently issued through the agency of Ridout and Maybee, Toronto, are the following: H. E. Angold and Wm. Duddell, distance operated mechanisms, and signals connected to electric supply systems; Henry P. Baird, air moistening and filtering attachment for radiators; G. and J. Weir, Limited, control device for rotary pumps.

PRELIMINARY ANALYSIS OF THE DEGREE AND NATURE OF BACTERIAL REMOVAL IN FILTRATION PLANTS*

By Abel Wolman
Division Engineer, Maryland State Department of Health.

THE determination of a law of bacterial removal by rapid sand water filtration plants is of great practical importance and utility. Such determinations of plant efficiencies are valuable as indicators not only of present but also of future performance. The objection is, however, often justly raised against the attempt to predict quantitatively the possibilities of bacterial removal, that existing numerical measures of performance are misleading and in some cases even harmful. The calculation of percentage removal from raw water to efficient is an illustration of the type of measure which has arithmetical accuracy, but little logical basis. It is quite evident, however, that it would be desirable to measure quantitatively the performance of a plant in such a way as to obtain a comparative conception of how well or how badly it is being operated. Since at present no agreement exists among operators, designers, or public health officials as to a standard of "good performance"—because in the past, agreement has been prevented by the interminable search for a "standard effluent," itself the subject of disagreement—it becomes necessary to attack the problem of rating or standardizing plant accomplishment from another angle. In this discussion, an initial search is made for certain basic characteristics of rapid sand filtration. The term "rapid sand filtration" is here used more broadly than usually, to describe the entire process from preliminary coagulation through sedimentation or settling, filtration, and disinfection. The measure of variable phenomena by comparison with ideal or "normal" conditions is a procedure common to scientific analysis. The application of this method offers here a fruitful means of testing our ideas of filtration efficiency. The first problem obviously consists in the attempt to determine a possible correlation between the number of bacteria in the final effluent of a filtration plant and the number in the raw water. A numerical statement of a problem should be clearer. If a plant uses a raw water containing 500 bacteria per c.c. and produces an effluent containing 10 per c.c., will the same plant produce an effluent of 20 per c.c., when the raw water content is 1,000 per c.c.? Can one predict, in other words, with any degree of precision, what effluent counts should be normally attainable with varying raw water counts?

Normal Empirical Performance

The normal or ideal performance from which it is possible to obtain hypotheses as to standard empirical accomplishment is not difficult to deduce. The "normal empirical performance" may be defined as the accomplishment of a filtration plant which is known to be operating successfully. Successful operation can be said to exist wherever there is an unquestioned superior bacteriological and physical quality of effluent, consistent performance, excellent control, and scientific observation of operating details. In this analysis, the operating statistics of the filtration plant at Avalon, Maryland, owned by the Baltimore County Water and Electric Company and operated by Mr. S. T. Powell, were used. This plant obtains its raw water from the Patapsco River, a highly polluted stream, ranging in turbidity during the year from 0 to 5,000 parts per million and in bacterial content (20° C.—gelatine—48 hours), from several hundred to 150,000 per c.c. The watershed of the stream is composed largely of cultivated areas, with no large sewage polluting influences. This water is treated with aluminium sulphate, at an average rate of 0.8 grain per gallon, and is then allowed to settle for four hours. After leaving the sedimentation basin it is treated with calcium hypochlorite with an average dose of 0.34 parts per million, and then passes through the rapid sand filters which have a capacity of 2.5 million gallons per day. The plant is controlled scientifically by a trained operator with the aid of modern equipment and laboratory observation. During several years of operation the bacterial content of the effluent has not exceeded, at any time, 20 bacteria per c.c. Presumptive tests for B. coli in lactose broth have indicated positive tests in 1 c.c. less than 2 per cent. of the time during any year. The number and kinds of bacteria are determined in raw water and final effluent every day and general experimental data are constantly collected. It is clear, therefore, that the plant in Baltimore County approaches so closely, from the standpoint of operating results, the ideal plant as to justify the use of its performance as the basis of a law of filtration.

In order to determine with some degree of accuracy the form of a characteristic empirical performance curve, the results of raw water and final effluent counts of the Avalon plant were plotted. In order to avoid plotting, a mass of points which would tend to confuse seven-day averages of both stations, rather than daily results extending over a period of nineteen months in 1915, 1916 and 1917, were used. In plotting these values, approximately 520 daily analyses were summarized. These were obtained in consecutive months and under every phase of operating conditions. No counts were discarded as being unfair or incorrect.

The equation of a straight line, when the results have been plotted on a logarithmic basis, *viz.*, given by:

$$C = \frac{\log y}{\log x},$$

where C is a constant for this particular plant, and y and x are respectively the raw water and final effluent counts. It would appear, therefore, that the "normal empirical performance" is represented by a curve having the equation

$$C = \frac{\log y}{\log x} \text{ or } y = x^{c}.$$

A tentative hypothesis, with regard to bacterial removal by filtration action, may be promulgated, therefore, as follows: "The final effluent count, under normal operating conditions, is an exponential function of the raw water count." This hypothesis provides a means of determining whether or not a plant under scrutiny is, at least, "performing normally," where normal performance would be interpreted as conformity to the logarithmic curve of filtration.

A Fallacious Assumption

The "normal performance" curve demonstrates the fallacy of assuming that the difficulty of removal of bacteria is relatively the same regardless of the number of bacteria in the raw water. Although this assumption is rarely publicly proclaimed, it is usually summoned, however, to the aid of those plants which, for one reason or another, are so unsuccessful as to require a specious hypothesis, fairly reasonable to the layman, to support their claims to maximum efficiency of 99 per cent. plus. The practical results of a scientifically controlled plant certainly seem to lead to the conclusion that increases in raw water bacterial content decrease the corresponding

*Abstracted from a paper read before the St. Louis Convenion of the American Water Works Association.

bacterial content interval in the final effluent. It should be added, too, that the equation of normal performance

$$C = \frac{\log y}{\log x}$$

offers a new quantitative measure of the efficiency of any plant, obtained by evaluating in any case the constant, C. Such a measure, among other qualities, has the advantage of a rational basis and a practical significance.

Value of Coefficient of Efficiency

What absolute value this constant, C, or the so-called "coefficient of efficiency," should attain is dependent upon individual opinion of "good performance." It is of interest to note, however, that, in a survey of 19 rapid sand filtration plants, varying in size from 2.2 to 30.0 million gallons filtered per day, the coefficient of efficiency of 17 of these plants has attained an annual average of over 2.5. The raw waters which these plants had to treat contained turbidities ranging from an annual average of 1 to 561 parts per million, and average bacterial contents from 350 to 16,500 per c.c. The 19 plants chosen, therefore, for the evaluation of C, are representative, in their initial conditions, of rapid sand filtration. The probable existence of the law of filtration, $y = x^c$, combined with known values of C, practically attainable, gives the investigator of filtration plant accomplishment the fundamental criteria with which to measure both the character and the amount of removal in any particular plant. The objection may be raised to the above method of critical standardization of plants, that all do not function in a similar manner, on account of differences in raw water, resulting from peculiarities of suspended matter, variations in resistance of bacteria, and other similar factors. The objection does not seem to the writer to be entirely valid, since peculiar characteristics of raw water are usually provided for by variations in design, such as increased periods of sedimentation and greater doses of disinfectant. It is reasonable to suppose, therefore, that given plants, initially properly designed for local conditions, should function according to some common law, since death rates under disinfection, devitalization and sedimentation, and filtration of bacteria differ in the degree, but not in the kind, of changes effected. The preliminary theory of bacterial removal by filtration is supported by the average monthly results from several large rapid sand plants in the United States. Since the death-rate of bacteria under the action of disinfectants, and under well-defined conditions, has been shown to follow in general the law:

$$C = \frac{1}{t^2-t^1} \log \frac{y^*}{x},$$

it will be necessary to look for the causative factors of $y = x^c$ LAW in other phases of the system of rapid sand filtration. It is the writer's purpose to study further the bacterial removal in the individual and distinct processes of coagulation, sedimentation, and filtration proper, with a view to throwing further light on the problem of causation. Strictly speaking, the equation of a straight line curve plotted on logarithmic axes is $y = bx^c$, where b is the intercept on the y axis. In that case, C becomes

$$\frac{\log y - \log b}{\log x} \text{ rather than } \frac{\log y}{\log x}$$

Log b is infinitely small in our particular problem, since b, the intercept on the y axis, would be equivalent to those raw water counts which produce resultant final effluent counts of one. Since zero counts are rarely obtained in filtration plants, even with extremely low raw water counts, it is conceivable that the performance curve in the "normal operation" described above would intercept the y axis at some point approaching unit. Log b, therefore, would approach zero and could be neglected in the evaluation of C. It is evident, therefore, that

$$C = \frac{\log y}{\log x}$$

measures in each case, with sufficient accuracy, the slope or inclination of the performance curve, the significant index to the efficiency of bacterial removal.

FIREPROOFING SPECIFICATIONS

LAST year the committee on fireproofing of the American Society for Testing Materials submitted to that society a new tentative method for control of fire tests and classification of materials and construction as determined by test; also certain revisions of the existing standard tests for fireproof floor construction and for fireproof partition construction. In order that the proposed new standards should be as generally acceptable to the engineering world as possible, a series of conferences were inaugurated with representatives of the following technical organizations:

American Society for Testing Materials, National Fire Protection Association, U.S. Bureau of Standards, National Board of Fire Underwriters, Underwriters' Laboratories, Associated Factory Mutual Fire Insurance Companies, American Institute of Architects, American Society of Mechanical Engineers, American Society of Civil Engineers, Canadian Society of Civil Engineers, American Concrete Institute.

The recommendations of the committee comprised the joint action of the representatives of all these organizations. The results were very gratifying, and the work has been continued this year in the same co-operative way. Two conferences have been held.

The U.S. Bureau of Standards and the Underwriters' Laboratories conducted numerous experiments during the year investigating the adaptability of the proposed time-temperature curve for the control of fire tests. The curve operated so satisfactorily it was unanimously voted to make no change in it, nor in any other essential feature of the proposed new requirements.

The standards have been rearranged and simplified to some extent for sake of clearness, and the revisions of existing standards have been amplified to make them more definite. These changes, however, have not altered the general purpose of the requirements as submitted in tentative form last year.

The committee recommends that the proposed standard specifications for fire tests of materials and construction be referred to letter ballot of the society for adoption as standard. The effect of their adoption will be to discontinue existing standards and incorporate the whole subject of fire tests of materials and construction under one set of specifications.

The following is a report of the steel output of Canada in 1917, compared with two previous years, the December figures of last year being estimated:—

	1915. Tons.	1916. Tons.	1917. Tons.
Steel ingots	989,829	1,397,703	1,686,005
Direct castings	31,067	30,546	42,807
Total steel	1,020,896	1,428,249	1,728,812

The relative output of electric steel was as follows:—

	1915. Tons.	1916. Tons.	1917. Tons.
Electric steel	5,625	19,639	39,069

BOMBARDMENT OF PARIS*

By Robert K. Tomlin, Jr.
Formerly Managing Editor, Engineering Record of New York

When the first bombardment of Paris by the long-range German gun followed a night of bombing by enemy airplanes, no one at that time realized that shells were being sent into the city from a point behind the front line trenches, which are at least 75 miles from the centre of the city. I was out on the streets the morning the bombardment began and everybody was under the impression that it was a daylight air raid, something entirely new, as of course all of the previous air raids had been engineered under cover of darkness. The sky above Paris was thick with French fighting planes, scooting here and there in search of enemy machines. It was not until late that day that we realized that the explosions did not come from bombs. The excitement was intense and everyone was mystified, for explosions were occurring at regular intervals of about twenty minutes, and no enemy machines could be spotted overhead.

Use Subway as a Refuge

The regular *alerte*, which is a warning sounded at the approach of German bombing machines, was given early in the morning, and both the "Metro" and the "Nord-Sud," the two Paris subways, were shut down in order that the stations, platforms and underground tubes could be used as a refuge by the people of Paris. The tramways, or street railways as we would call them, stopped operation. Cars were emptied, motormen and conductors left their platforms, and the rolling stock was left standing in the street wherever it happened to be when the *alerte* was given. Traffic was absolutely paralyzed and the only wheels turning were those of the taxi-cabs.

As a matter of fact, the shutting down of the subways in order to furnish underground retreats for the population defeated the very purpose for which it was done. In an hour or two, people got tired of staying under ground and came up for a breath of fresh air. Many of them had to get from one part of the city to the other, and the only way of doing this was by walking along the streets. Therefore, with the subways shut down, there were far more people on the streets and subject to danger from explosions of shells than would have been the case if the lines had continued their normal operation. This fact evidently was appreciated later, for during succeeding bombardments by the long-range gun, the subway system has continued in operation.

Bombs Do Most Damage

The damage done by the long-range gun is much less than that which results from the dropping of bombs by an airplane. I have seen a good many of the buildings hit by the long-range shells and they seem to damage only the upper two stories. The bombs, however, wreck things to a greater depth, sometimes as much as four stories. It often happens that when a shell strikes, the panes of glass on the opposite side of the street are shattered, while those on the same side remain intact.

Detonations of explosives are such a regular event here that the storekeepers are going to great trouble to protect their windows from breakage. The favorite stunt seems to be to paste across the glass long strips of paper. It has been interesting to watch the development of this form of protection. Originally two diagonal bands were pasted across the window. Then someone with an artistic touch got busy and produced a design of squares and triangles like the strips of pastry on an old-fashioned cranberry pie. He soon had a large following and now the windows present designs of every conceivable pattern. It seems to me that these Parisian shop-keepers have something to learn in the matter of window protection from New York merchants, whose stores were situated along the excavations for the new subway lines. There, it will be remembered, the favorite trick was to truss the panes with diagonal wires and struts at the centre. I have yet to see one of these rigs in service here. The gummed strips of paper, however, apparently have official sanction for the windows of the Ecole Nationale des Ponts et Chaussées are "dolled up" in this way.

The city authorities are busy providing shelters or *abris* for the people during air raids. These are generally cellars of buildings not less than four stories in height. On the entrances to buildings containing cellars which have been officially designated as *abris* are big paper placards indicating the capacity of the shelter. Going along any street in Paris now you see on the buildings these placards with the words "150 places," "80 places," etc. Some of the cellar *abris* had window gratings fronting on the streets. At the present time all of these are being blocked up with plaster to intercept shell splinters.

Although the subway is now kept running during daylight bombardment by the big gun, it is closed down during an air raid at night. Those people who seek underground shelter on such occasions now take the experience pretty much as a matter of course, and during the last raid I saw people filing down stairs into the Etoile station of the "Metro" with camp-stools, chairs, newspapers and magazines, and other aids to comfort during the two or three hours sojourn below street level.

"La Grosse Bertha"

When a night air raid starts, the fire engines are sent at full speed through the streets with their sirens going full blast, church bells outside of Paris start ringing, and factory whistles add to the discord. New stationary sirens are in course of installation. Pretty soon the anti-aircraft guns start booming on the outskirts of Paris and from my window I can see the flash of the shells as they burst in mid-air. It looks just like the bunch of sparks produced in grinding metal with an emery wheel. In twenty minutes or so after the guns have started the airplanes which have managed to break through the barrage begin to "lay their eggs." It is very easy to distinguish between the detonation of bombs and the burst of the shrapnel from the "Archies." The bomb makes a deep roar while the shrapnel produces a higher staccato note.

Paris is not greatly disturbed by the shelling of "le canon à longue portée" which is generally dubbed by the French newspaper writers as "La Grosse Bertha." People go about their business very much as usual. The moving pictures are taking a fling at the big gun in a humorous way. At the last performance I attended there was shown an "animated cartoon" in which "La Grosse Bertha" was sending over shells and Charlie Chaplin (whom they call Charlot over here) was catching them, standing forth as the defender of Paris. After he had caught three of these the cartoon showed him juggling them, and finally hurling them back in the direction of Berlin.

While many persons have departed from Paris as a result of the air raids and bombardment, the bulk of the populace is taking the matter calmly. I have yet to see anything in the nature of a panic.

*A letter written to the Engineering News-Record of New York.

COL. LOW RESIGNS AT HALIFAX

GEO. H. ARCHIBALD, of the firm of Archibald and Holmes, Ltd., engineers and builders, Excelsior Life Bldg., Toronto, has been appointed manager of the reconstruction department of the Halifax Relief Commission in place of Col. R. S. Low, who has resigned.

Having completed practically all of the work of the commission which needed urgent attention, and, in fact, having completed practically all of the work of the reconstruction department excepting the rebuilding of the devastated area, Col. Low felt that his work of organization of the department had been completed and that he should resign in order to devote attention to the affairs of his own company, which has taken on some very important contracts recently, including the new Federal Office Building in Ottawa, a $1,000,960 contract, and the big plant at Deschene, P.Q., for the British-America Nickel Corporation, which he is to complete before snow falls.

Col. Low has given six months' time without remuneration to the Halifax Relief Commission. He told the commission when he assumed control of the reconstruction department, that he would be able to stay only until the more urgent affairs had been disposed of, and that he would not be able to supervise the town planning or reconstruction of the devastated area.

SEWER PROJECT AT MONTREAL

REPORTING in favor of an improvement scheme to cost $1,632,997, a commission which has inquired into the sanitary conditions of the River St. Pierre, Montreal, states that this amount could be reduced by adopting tunnel methods on the part of the work under the Lachine Canal. The report on the plan has been prepared by J. H. Valiquette, engineer in charge of the western division of Montreal, and one of the members of the commission.

The plan is divided into five sections, the estimates for which are as follows: 1, River St. Pierre intercepting sewer, tail race of the aqueduct to St. Ambroise Street, $640,000; 2, Pressure conduit attached to River St. Pierre intercepting sewer, to take care of Westmount intercepting sewer, $194,000; 3, Inverted syphon under Lachine Canal, $520,000; 4, Westmount intercepting sewer, $206,478; 5, Deepening of channel outlet, $72,519.

It is believed that this scheme will do away with the floods and noxious smells which have been a menace to public health in the district drained by the River St. Pierre. Mr. Mercier, chief engineer of Montreal; Mr. Roy, engineer of St. Pierre aux Lieux; Mr. Laframbroise, engineer of Lachine; and Mr. Lafreniere, engineer of the Quebec provincial board of health, were members of the commission.

Regina, Sask., will vote on a by-law to spend $175,000 on extensions to the municipal electric light and power plant.

Building permits issued at Welland, Ont., for the month of May, 1918, totalled $93,029, compared with $37,846 for the corresponding month last year. The total for the year 1918 to June 1st is $176,724, compared with $133,195 for the same period last year.

Sorel, P.Q., may have a new pumping plant and also a filter plant at a later date. E. Gill, town engineer, has drawn plans for improving the aqueduct and for the installation of new pumps to replace the existing ones. One pump will have a capacity of 1,500,000 Imperial gallons per day to be used for domestic supply, and the other will have a capacity of 3,500,000 per day for fire protection.

HIGHWAY MATERIALS PUT ON FAVORED LIST FOR U.S.A. CAR DISTRIBUTION

HIGHWAY materials have been placed next to coal, coke and ore, on the preferential list for car supply, by the car service section of the railroad administration of the United States Government. This ruling applies particularly to stone, sand and gravel for maintenance and essential road construction. The aim is to assure the proper care of roads already built, and the construction of those necessary for the carrying on of the war. The regulations issued are as follows:—

1. Open top cars, suitable for such traffic, should be furnished preferentially for the transportation of coal, coke and ore.

2. Available open top cars, not suitable for the transportation of coal, coke and ore, may be furnished for the transportation of stone, sand and gravel, and when so furnished shall be used preferentially for highway maintenance materials.

3. Open top cars, suitable for the transportation of coal, coke and ore, and available on coal, coke or ore producing roads in excess of the demand of such commodities, may be furnished for the transportation of stone, sand and gravel, and when so furnished shall be used preferentially for highway maintenance materials. The return movement to mines or ovens should be utilized wherever practicable in furnishing car supply for stone, sand and gravel. Every endeavor should be made, consistent with keeping up the production of coal, coke and ore, to furnish shippers of stone, sand and gravel with a minimum of forty per cent. of their normal weekly transportation requirements.

4. Roads which are not producers of coal, coke or ore must not use foreign open top equipment for stone, sand or gravel shipments, except for one load in the course of the return movement to mines or ovens.

5. Where the transportation needs of essential road construction or maintenance projects cannot be met by car supply furnished in accordance with the above rules, the state, county or municipal officials in charge of the work, should, through their proper state highway department, apply to the Director of the Bureau of Public Roads, United States Department of Agriculture, Washington, D.C., for assistance. Such applications will be considered by representatives of the Department of Agriculture, the War Department, the War Industries Board, the fuel administration and the railroad administration, and in accordance with the recommendations of such representatives, the Car Service Section will endeavor to furnish car supply necessary for approved essential road construction or maintenance.

It must be understood that car supply for stone, sand and gravel must not be permitted to jeopardize the essential production of coal, coke or ore. If at any time such a result is apparent on individual roads, or generally, orders will immediately issue to curtail the car supply for stone, sand and gravel.

Madigan & Darbyson, engineers and contractors, have dissolved partnership. W. H. Madigan continuing the business on his own account with office at 30 St. John St., Montreal.

The arbitration between the Cook Construction Co. and the city of Montreal to assess the damages caused by the cancellation of the contract for the construction of the aqueduct, and by the breaking of the water conduit, has now been concluded. The arbitrators are J. M. Fairbairn, W. F. Tye and A. Geoffrion, K.C. The arbitrators visited the conduit and also heard evidence from several United States and Canadian experts.

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Principal Contents of this Issue

TRADE RESTRICTIONS MAY PROVE BENEFICIAL IN DEVELOPMENT OF NATURAL RESOURCES

TRADE restrictions announced by Canada's War Trade Board will have a salutary effect upon manufacturing conditions in Canada. More raw materials will be worked into marketable commodities instead of being exported to the United States and then imported again as manufactures. As stated by Mr. Edward T. P. Shewen, of St. John, N.B., consulting engineer to the Public Works Department of Canada, in his contribution to the eighth annual report of the Commission of Conservation: "In exporting raw material, a country derives from its natural products the least advantage."

Referring to this aphorism, Mr. C. E. W. Dodwell, of Halifax, in his contribution to the report of the Committee on Conservation presented at the last annual meeting of the Canadian Society of Civil Engineers, says that this enunciation is a flash of genius, entitling Mr. Shewen—until and unless he disclaims originality—to the Nobel prize for the year or the Cordon Bleu of the Academy. "The only proper way in which Canada can ever hope to pay the interest, to say nothing of the principal, of the numerous loans that have been raised to justify and maintain our proud position in the Empire," says Mr. Dodwell, "will be to exploit and develop on sound business principles the almost unlimited natural resources within our borders.

"Take the crudest but most forceful case. A ton of pig iron to-day is worth about $56; converted into watch springs it is worth nearly $40,000. In the process of conversion it is increased seven-hundred fold in value. The enormous sum of nearly $40,000 has been added to its value, this sum representing the difference between its actual and its potential value.

"This is admittedly and purposely an extreme case, but the principle underlies the whole subject. A cord of pulpwood is worth six or seven dollars. Ground into pulp it is worth about $20; converted into paper, even the cheaper form of wrapping paper, it is worth over $200. A ton of gypsum is worth a couple of dollars. Calcined and ground, and thus converted into wall plaster, it is worth about $16, an eight-fold increase."

These are but three of numerous similar examples which could be quoted. In order to grapple vigorously with these and other problems, and to insure proper co-ordination of effort, Mr. Dodwell suggests that a new department of the Federal Government be created. He would call it the Department of National Development, or the Department of Conservation and Development, or the Department of Development and Industry, or the Department of Conservation and Industries. In it he would group and co-ordinate the Commission of Conservation, the Honorary Advisory Council for Scientific and Industrial Research, the Fuel Testing Laboratories, the Forest Products Laboratories and all other government branches or sub-departments which are connected with any feature of development or research. He suggests that the new department be manned by a staff of scientific men and fully equipped with funds for carrying on extensive research work in many branches of scientific industry.

DOMINION POWER BOARD

IN accordance with the resolution passed at the last annual meeting of the Canadian Society of Civil Engineers, the Dominion Government has appointed a Power Board to co-ordinate the development of fuel and power. The government is to be congratulated upon its action. Such a board is necessary to ensure the greatest economical advantage from the use of our national resources.

Few other countries are so fortunate in the advantages accruing from splendidly located water power and coal, and few countries have used such advantages to so great an extent as the people of Canada. During the period of the war, there have been many unfortunate but, it is hoped, temporary difficulties in meeting the urgent demand for fuel for domestic purposes and power for manufacturing. Unless a deliberate attempt be made to have the use of our water powers and our fuel resources co-ordinated, and a policy evolved which will realize such co-ordination in the years to come, the recent difficulties in fuel and power needs will be aggravated. The government has, therefore, taken a wise step in constituting a permanent board for the consideration of problems of such vast importance to all parts of the Dominion.

Cheap power promises to be one of Canada's greatest assets in the post-bellum industrial rivalry of nations for world trade. Our fuel resources, supported by our water powers, should be a sure source of cheap power, and should guarantee Canada her share in world trade, if they are availed of to their maximum possible advantage.

MOBILIZING CANADIAN LABOR

IN mobilizing the nation's full labor power, the government has taken proper action. The times demand deeds, not words. The fate of liberty-loving nations trembles in the balance. Recalling with just pride what her sons have accomplished, fully assured that their courage will meet every test, that their will for

victory is inflexible, Canada with quiet confidence will do her duty in this hour of crisis and of peril.

We are convinced that every man, woman and boy has a present supreme duty to the State—the duty of performing useful, productive work. Distinctly war work must come first in the country's economic programme; the production of munitions, clothing, ships, and food and the scores of accessories required for efficiently carrying on the war. Thereafter, and after all primary demands have been met, the machinery of production must be kept in full operation to the end that the wealth essential for financing national requirements, on war account, will be forthcoming.

The mere possession of property, or income from investments, gives no one the right during these hard days to live a life of leisure. Not for an instant can the people of this country forget or neglect the men who are giving their all that liberty and justice may not perish from the earth. The vast majority of men of means have done their part. The others must.

Methods have been devised under a recent order-in-council to eliminate the shirker and all others who are voluntarily idle. Magistrates everywhere should relentlessly enforce the provisions of the law.

Senator McCumber recently introduced a bill into the United States Senate providing for the registering of all male citizens between the ages of 16 and 62, and for subjecting them to "the call of the government to perform such service in transportation, ship-construction and war-supplies as the government might require." This bill, in all probability, will not at present be made the law of the land, as it embodies the principle of industrial conscription. Nevertheless, the American nation will not permit the word "conscription" to terrify it, if circumstances demand drastic action. Their military record proves that beyond any possibility of doubt. Within six weeks of the declaration of war the draft measure was on the statute books.

The Canadian administration likewise does not propose the conscription of labor at this juncture. Nevertheless, conscription will come if it be found essential for the winning of the war. France and the United Kingdom have had virtual conscription from the outbreak of hostilities. Workmen were not free to move from place to place, and from trade to trade, as in peace times. In the United Kingdom, as is well known, a workman could not hope to leave his job and get employment elsewhere unless he had secured a certificate showing that he had been honorably discharged.

PERSONALS

J. W. Shackleton has been appointed city engineer of Chatham, Ont.

F. L. Butler has been appointed general superintendent of the Winnipeg Electric Railway, succeeding Wilson Phillips.

A. R. Webster, formerly of the Northern Ontario Light and Power Co., has been appointed inspector of mines for Ontario.

C. H. Lee, of the British Columbia Electric Railway, has received a commission as lieutenant in the U.S. Navy Civil Engineering Corps.

John Vass has been appointed assistant master mechanic of the Ontario lines of the Grand Trunk Railway with headquarters at Allandale, Ont.

Lieut. Harold John Mackenzie, a graduate of the School of Practical Science, 1914, who went overseas with the 1st Tunnelling Company Canadian Engineers, has been decorated.

Brig.-Gen. F. O. W. Loomis, of D. G. Loomis and Sons, general contractors, Montreal, was included in the list of those honored on the King's birthday. He was made a Companion of the Bath.

M. W. Plumb has resigned as managing engineer of the Pneumatic Concrete Placing Co. of Canada, Limited, Montreal, to accept a position in the traffic department of the Emergency Fleet Corporation, New York City.

Capt. George C. Blackstock, of Toronto, has been awarded the Military Cross. He was a student in engineering at the University of Toronto in the class of 1915, but enlisted immediately after the declaration of war.

W. H. Farrell, terminal superintendent of the Grand Trunk Railway in Toronto, is severing his connection with the company to assume the position of general manager of the Algoma Eastern Railway Co., with headquarters in Sudbury, Ont.

Lieut. J. S. Galbraith, of the 123rd Pioneers, who came home from France a couple months ago on sick leave, is to get his discharge as physically unfit. Lieut. Galbraith is a son of the late Dean Galbraith, of the School of Practical Science, Toronto. He graduated in 1913 in civil engineering at the University of Toronto. He served in France for eighteen months but was invalided home after a gas attack.

T. H. Hogg, assistant hydraulic engineer of the Hydro-Electric Power Commission of Ontario, will address the Association of Municipal Electrical Engineers at the first regular meeting of that association, to be held at Niagara Falls, Ont., June 14th and 15th. Mr. Hogg's subject will be "The Chippewa Creek Power Development Scheme." After his description of the project, the delegates will be motored over the site of the proposed power canal.

O. W. Meissner, of Montreal, and C. N. Schrag, of Toronto, are organizing a new manufacturers' agency firm to be known as Equipment Specialties, Limited, successors to O. W. Meissner, Limited, of Montreal. Mr. Schrag recently resigned as sales manager of the Bawden Pump Co., of Toronto. The new firm will have offices at 10 St. Antonie Street, Montreal, and 1409 Royal Bank Building, Toronto. Among the agencies secured are the following: Gardner Governor Co., Quincy, Ill., duplex steam pumps and air compressors; Homestead Valve Mfg. Co., Homestead, Pa., plug cocks; C. M. Davis Regulator Co., Chicago, Ill., pressure reducing valves, governors, altitude and back-flow valves; Metallium Refining Co., Omaha, Neb., jointing for water and sewer pipes; Moore Steam Turbine Corporation, Wellsville, N.Y.; Mulconroy Co., Philadelphia, Pa., hose and other mechanical rubber goods; A. Wyckoff & Son Co., Elmira, N.Y., wood-stave pipe and steam pipe casings; and Pacific Coast Pipe Co., Vancouver, B.C., (agency for Ontario, Quebec and East) wood-stave pipe and tanks.

OBITUARIES

Raymond Chartrand, a former contractor, died June 4th, in Montreal. Mr. Chartrand was 82 years of age. He was the contractor for the post-office, the court house and many other public buildings in Montreal.

George Fee died on May 25th at his residence in Westmount, P.Q. Mr. Fee retired about fifteen years ago from the firm of George Fee & Co., railway contractors, who completed a section of the C.P.R. in 1885.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Chippawa-Queenston Power Development

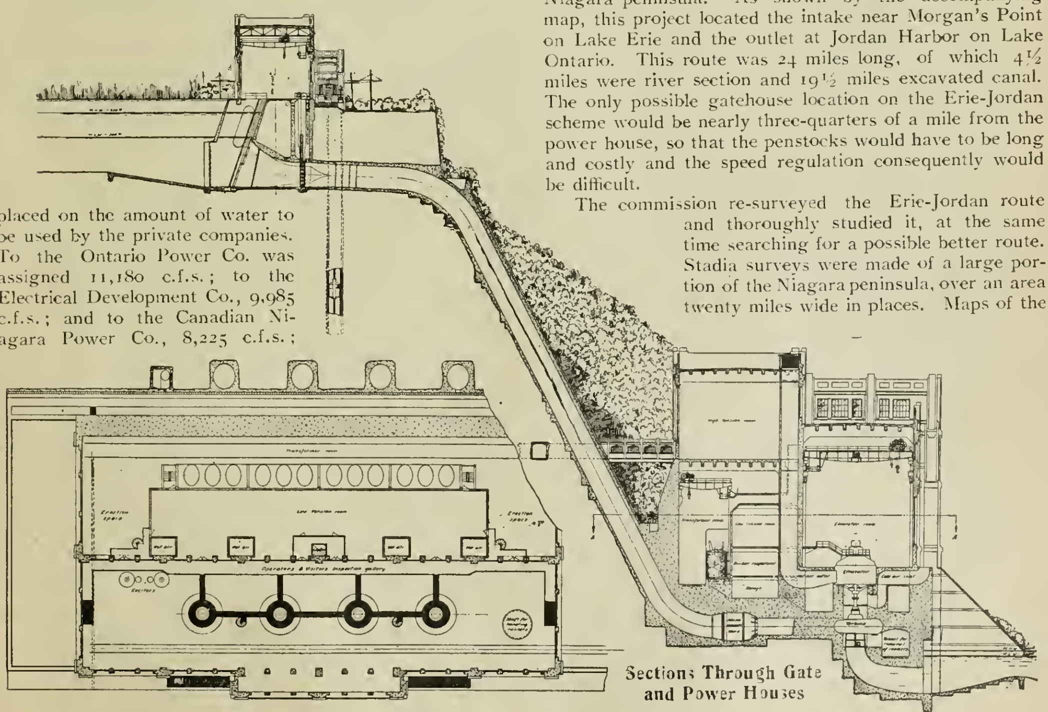
Hydro-Electric Power Commission of Ontario Will Develop 300,000 H.P. Under 305 Ft. Net Head, Using 10,000 C.F.S. from the Niagara River—Largest Hydro-Electric Power Scheme Ever Undertaken—Units Will Be of 50,000 H.P. Capacity—15,000,000 Cu. Yards of Excavation—Plant Could Be Extended to Million Horsepower

BETWEEN Lake Erie and Lake Ontario, the difference in level is 330 feet; but to date the maximum net head utilized by any Canadian hydro-electric power development on the waterway joining those lakes, is about 160 feet. On account of the shortage of hydro-electric power in Ontario, and because of the comparative inaccessibility to manufacturing centres of the other undeveloped water powers, the Hydro-Electric Power Commission of Ontario realized many years ago that more economic development at Niagara would be necessary.

The treaty which was enacted by Great Britain and the United States in 1910, limits to 56,000 c.f.s. the amount of water which can be diverted for power purposes from Niagara's 220,000 c.f.s. mean flow. Of this amount, Canada is entitled to 36,000 c.f.s. By an Ontario order-in-council passed in 1915, a limit was placed on the amount of water to be used by the private companies. To the Ontario Power Co. was assigned 11,180 c.f.s.; to the Electrical Development Co., 9,985 c.f.s.; and to the Canadian Niagara Power Co., 8,225 c.f.s.; leaving only 6,610 c.f.s at the disposal of the commission. The Ontario Power Co. has since been purchased by the commission, however, so that the commission now has within its control a total of 17,790 c.f.s.; and, of course, alterations in the treaty may possibly be made from time to time to meet new conditions, or the commission may purchase one or both of the remaining two private concerns.

Two of the existing Canadian plants are said to be working under net effective heads of less than 135 ft. The commission determined to use more of the 330-ft. head between the two lakes. For the past twenty years various schemes, more or less practical, had been suggested. One of the best of these was a route that had been surveyed many years previously by the consulting engineering firm of Smith, Kerry & Chace, of Toronto. This route, called the Erie-Jordan Canal, cut across the Niagara peninsula. As shown by the accompanying map, this project located the intake near Morgan's Point on Lake Erie and the outlet at Jordan Harbor on Lake Ontario. This route was 24 miles long, of which 4½ miles were river section and 19½ miles excavated canal. The only possible gatehouse location on the Erie-Jordan scheme would be nearly three-quarters of a mile from the power house, so that the penstocks would have to be long and costly and the speed regulation consequently would be difficult.

The commission re-surveyed the Erie-Jordan route and thoroughly studied it, at the same time searching for a possible better route. Stadia surveys were made of a large portion of the Niagara peninsula, over an area twenty miles wide in places. Maps of the



Sections Through Gate and Power Houses

district were drawn and 2-ft. contours plotted. Test borings were taken every 500 ft. with an Ingersoll-Rand Calyx core drill, the cores still being stored for reference.

New Route Located

When the route was discovered which was tentatively decided upon, wash borings, or well-drill borings, were made every 500 feet on the centre line of the proposed canal, to provide an accurate sub-surface profile. A large number of photographs of the district were taken, and also photographs of ice conditions at the proposed intake. The Welland River was sounded, stream measurements were made on the Welland and Niagara Rivers, and the history of the levels of the Niagara River and Lake Erie for the past sixty years was closely studied. The directions of the lines of flow at the proposed intake were noted, and there were obtained all the data necessary for the construction of hydraulic similarity models.

As a result of the surveys and studies, it was decided to adopt for the Hydro Power Canal, the route shown on the accompanying map. This route is about 12¾ miles long, with the intake on the Niagara River at Hog Island, Chippawa, about two miles above Niagara Falls, and the tailrace on the Niagara River about one mile above Queenston. The intake will be in what is known as the Grass Island pool of the Niagara River. The mean monthly elevation of this pool varies about 1 ft.

Map of the Niagara Peninsula, Showing Canal Routes for Chippawa-Queenston and Erie-Jordan Schemes

Ideal Intake and Tailrace Location

The normal mean elevation of Lake Erie is 573; of Grass Island Pool, 561; of the Niagara River at the power house site, 245; and of Lake Ontario, 243. Probably no other river has more uniform regulation than the Niagara. The minimum flow is half the maximum, and the section is so large that over a period of fifty years the maximum difference in mean monthly levels under normal conditions, either at Chippawa or Queenston, amounts only to about six feet.

The ideal intake and the ideal power house location were first determined with a view to the maximum utilization of the available head, and contours and borings were then studied to decide by what route a canal could connect those two points to the best hydraulic and economic advantage. The intake was located at Hog Island partly on account of that point being just above the critical section at which the water begins to speed up for its passage over the falls. Location further up the river would have meant a larger canal; further downstream, a loss in head. Another reason quite equally important for locating the intake at Chippawa was the use which could be made of the natural channel of the Welland River—often called Chippawa Creek—which provides about 4¼ miles of the Hydro Power Canal, leaving only about 8½ miles to be excavated, although the Welland River will have to be somewhat deepened and widened. The flow of the Welland River, which is a sluggish stream with a very flat bed, will be reversed.

The Hydro Power Canal's 8½ miles of excavated section compares with 19½ miles for the Erie-Jordan scheme, and the gross head is 316 ft. compared with 299 ft. for the Erie-Jordan.

The ice troubles that would be experienced in the Erie-Jordan scheme will also be more readily obviated. Ice would have caused immense expense in the Erie-Jordan intake, particularly during east gales, but no such trouble is anticipated at Hog Island. There will be elaborate methods of ice protection at the intake and also at the forebay, to eliminate the troubles experienced at the existing plants.

Only 11 Ft. Loss of Head

The gradients adopted for the Hydro Power Canal average about 1 ft. per mile, or a total of about 8 ft. in the 8½ miles of excavated canal. The loss of head in the penstocks, due to friction, may amount to upwards of 2½ ft., and the loss in the Welland River from Hog Island to Montrose, where the excavated canal begins, will be about 6 inches under maximum load, so that the total loss of head will be only 11 ft., making the net effective head about 305 ft. under average normal conditions. Thus, of the 330 ft. normal difference in level between the two lakes, only 25 ft. head will be lost,—12 ft. between Lake Erie and Hog Island, 11 ft. between the intake and the tailrace, and 2 ft. between the point of discharge of the tail water and Lake Ontario.

The power house will be located down in the gorge, about three-quarters of a mile above the Lewiston Bridge, just at the end of the last rapids in the river. The location is ideal, the best on the Canadian side of the river and probably better than any on the American side, as it affords facilities for the extension of the power house to any degree desired, even to use the whole 40,000 c.f.s. which the U.S. War Department says is the maximum that should be diverted from the Niagara Rapids. The cliffs are nearly vertical at the power house site, which gives the ideal condition, as the gatehouse will be on the cliff just a couple of hundred feet back of the power house, with the results that the penstocks will be nearly vertical and only about 450 ft. long, so that their cost is reduced to the minimum, the loss of head in the penstocks is reduced to the minimum, and the use of surge tanks

is avoided. The penstocks are so short that they can be designed to withstand the stresses due to pressure surge. Valves may not be required on the penstocks; regulation will be effected by the gates at the gatehouse and by the wicket gates on the turbines.

About 30 h.p. will be obtained from each second-foot of water, compared with about 14 h.p. obtained by the existing plants. With 36,000 c.f.s., over 1,000,000 h.p. could be developed at this plant, compared with less than half that amount at the heads under which the present plants are operating.

Most of the excavated section of the canal will be in rock, but at the Whirlpool there is a stretch which is in earth; and the initial portion of the excavated section, adjacent to the Welland River, will also be in earth.

Canal Mostly in Rock

Starting at the point of diversion from the Welland River, near Montrose, as station 0, the earth section extends to station 80, a distance of 8,000 ft. Then the canal is in rock all the way to the gatehouse excepting at the Whirlpool, where it is in earth from station 332 to station 351. At station 351 it is in the full rock section again, but the sub-base of rock crops up gradually far ahead of station 351, with the result that only about 1,000 feet, or from station 332 to about station 342, is entirely in earth at this part of the canal. The station at the gatehouse site is 462, a distance of 46,200 ft. from the diversion at Montrose.

The stations on the Welland River section are separately numbered, beginning at Hog Island as station 36, allowing 3,600 ft. for future allotment to plans for the intake works that will be constructed in the Niagara River. The diversion at Montrose is at station 222 + 40, a distance of 18,640 ft. from Hog Island. The total length of the Hydro Power Canal from Hog Island to the gatehouse location is 64,840 ft., or 12.28 miles.

The gradient and the section adopted for the canal are the most economical for the amount of water which it is desired to pass through the canal. The canal is nominally designed for 10,000 c.f.s. at minimum low water. The rock is mostly very good limestone, and as all the rock will be channelled, and may be lined with concrete where it is too poor to channel smoothly, the friction will not be great. Ten Sullivan channellers, each having a 20-ft. cut, will be used on each side of the canal.

Earth Sections Will Be Lined

The earth sections will be lined in some manner not yet finally decided. The sides of the wetted section will be sloped 1½ to 1 and they will either be "gunited" over light reinforcing, by the Cement-Gun method, or else a heavier reinforcing will be used and the walls will be poured. This detail of design and many other details of the scheme are in a state of flux and will be decided only from time to time as the work progresses. As the commission is both the buyer and the contractor, there is no necessity for rigid decision in advance in regard to details of this sort, the commission being able to leave them for disposal as circumstances may dictate. The entire construction programme is liable to change in any detail at any time should conditions, as the work progresses, suggest changes.

The rock section is 48 ft. wide at the bottom, with perpendicular sides, the average wetted section being 35 ft. deep. The velocity in the rock section will be about 6 ft. per second when the plant is under maximum load. The banks of the overburden will be sloped 1½ to 1 unless local conditions in certain places require a flatter slope or other treatment.

The earth section will be 34.6 ft. wide at the bottom and 162 ft. at the top, the sides having a 1½ to 1 slope, the average wetted section being about 26 ft. deep. The width at the mean water line will be about 84 ft.

The commission has purchased a wide tract of land as a right-of-way, and has enough acreage to be able to build two more canals should they be required in the future. These canals would be located a few hundred feet to the west of the first canal and would be almost parallel to it. They would draw water from the Welland River just as the first canal will do. The capacity of these additional canals would, of course, depend upon the section and the gradient assumed, but could be built readily and economically to handle all of the water which both Canada and the United States are now diverting from Niagara Falls, should the people of the United States ever desire to merge their water allotment with Canada's, in one big plant, for the sake of higher efficiency. The cost of all this property is being charged against the present scheme. About $1,000,000 worth of land will have been acquired when the expropriations are complete. This includes the vast disposal area at St. David's, which can accommodate about 20,000,000 cubic yards of dumped material.

The canal's designed capacity of 10,000 c.f.s. at minimum low water refers to the absolute minimum during a period of about sixty years. The records for the Niagara River had been kept for fourteen years, and the records for Lake Erie had been kept for about sixty years, and from the Lake Erie levels the Niagara River levels were estimated for the period prior to the fourteen years for which direct records were kept for the Niagara River. This minimum low water has occurred only about once in fourteen years; the average monthly minimum is much higher; so, in assuming the absolute minimum, the

CHIPPAWA-QUEENSTON SCHEME IN TABLOID

Horse-Power Developed	300,000
Capacity of Units	50,000 H.P.
Number of Units	6
Diameter of Main Penstocks	13 ft. 6 ins.
Gross Head	316 ft.
Net Effective Head	305 ft.
Water Required	10,000 c.f.s.
Length of Canal	12¾ Miles
River Section	4¼ Miles
Excavated Canal	8½ Miles
Gradient in Ex. Canal, per mile	1 ft.
Width of Rock Section	48 ft.
Width of Earth Section	162 ft.
Earth Excavation	11,000,000 Cu. Yds.
Rock Excavation	4,000,000 Cu. Yds.
Deepest Cut	145 ft.
Surveys Started	1914
Construction Commenced	1917
Completion of Work	1921
Estimated Cost, about	$25,000,000

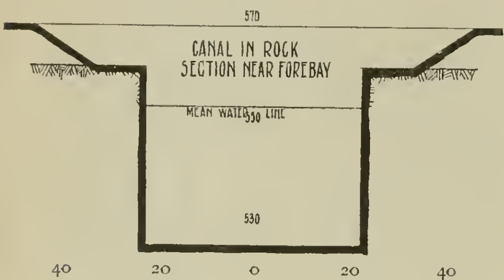
commission allowed a factor of safety which will provide against possible future contingencies.

The scheme as now laid out, using 10,000 c.f.s., will have a capacity of 300,000 h.p., and the canal, forebay, gatehouse substructure and power house substructure are designed for that capacity. The power house and gatehouse superstructures will be designed initially for 200,000 horse-power.

50,000 E.H.P. Units

There will be control works at the head of the excavated canal near Montrose, but from there the canal will be unobstructed until the forebay location is reached, which is at Smeaton's Ravine. At station 438+33, 2,367 ft. from the gatehouse, the canal widens into the forebay, the forebay gradually increasing in width to 300 ft., which will be the approximate overall dimensions of the gatehouse. The last 1,000 ft. of the forebay will be 300 ft. wide. The initial development contemplates four steel penstocks each about 13 ft. 6 ins. diameter, 450 ft. long, and one exciter penstock, about 5 ft. diameter.

There will be four units, each 50,000 h.p. capacity. Two more penstocks will be installed when it is desired to



bring the capacity of the plant up to 300,000 h.p. Both the gatehouse and the power house are designed so that they may be extended whenever conditions warrant and practically to any extent desired.

Single Runner Turbines, 187½ R.P.M.

The turbines will be of the single runner type, probably with cast steel scroll cases. The specifications call for 187½ r.p.m., which is the maximum safe speed giving satisfactory hydraulic characteristics. The specifications for the turbines have been prepared by the commission and prices will be secured in the near future. Although these turbines will have the greatest capacity of any water turbines yet designed, they will not be so large in overall dimensions as some others that have been built which operate at lower heads. The Keokuk and the Cedars Rapids turbines, for instance, are bigger than the commission's turbines will be, but the latter will be more powerful on account of the higher head. Steam turbines have been built of equally large capacity; in fact, the Westinghouse Co. are now said to be constructing for the Chicago Edison Co. a 75,000-h.p. steam turbine, with generator direct connected; but the units at the commission's power plant will be the biggest capacity hydro-electric units ever installed.

The commission has designs for a 100,000-h.p. turbine installation, and when the plant is increased from 200,000 to 300,000 h.p. it may be done by installing just one 100,000-h.p. unit instead of two 50,000-h.p. units. It was decided to install the smaller units for the initial development on account of the proportion of the plant which would be tied up should one of only two big units have to be shut down for any reason.

The power will be taken off the generators at 12,000 volts and will be stepped up, probably to 100,000 volts, for long-distance transmission. Elaborate arrangements will be made not only for leading cool air to the generators, but, what is more unusual, for taking the heated air out of the power house. Large ducts will lead cold air to below the rotors, and after the air has gone through the generators, it will be carried away in flues. There is also a scheme for removing the runners from the turbines without dismantling the turbines and generators, which will weigh about 1,000 tons, the moving parts weighing about 500 tons. Each draft tube will be so arranged that the runner can be dropped into the draft tube, loaded onto a car, pulled through a tunnel and lifted through a shaft by a crane, so that repairs can be effected without dismantling the unit.

The power house will be served by two 300-ton electric cranes. Over the power house will be a large suite of executive offices.

Maximum Cut at Lundy's Lane

Chief Engineer Gaby says that the plant will be turning over in the spring of 1921. Meanwhile temporary extensions are being made at the Ontario Power Company's plant to provide needed power. A large amount of construction plant is necessary in order to complete the tremendous amount of excavation within the time required. While the wetted section of the canal is mostly in rock, there is a considerable amount of overburden to be stripped. The maximum cut is at Lundy's Lane, where the ground elevation is 664 and the elevation of the bottom of the canal is 519, making a cut of 145 ft., of which about 70 ft. is overburden. The average cut over the four miles of the canal adjacent to the Welland River is about 80 ft., of which about half is overburden, while the average cut of the four miles adjacent to the forebay is about 50 ft., mostly rock.

In the concrete-lined sections the soil is a sandy clay and very firm, but some of the overburden is quicksand. The excavation will proceed from the forebay toward the Welland River, so that the quicksand will be given every opportunity to drain through the canal itself. It is expected that pumping will have to be resorted to at times, and occasional slides may be expected, but no undue difficulty is anticipated.

The borings show a considerable number of pockets of water in the sub-base. As all of these are under pressure, it is thought that a number of springs will flow into the canal and that these will slightly augment the flow of water in the canal. During excavation these springs will be allowed to drain down the centre line of the canal, the excavation proceeding upgrade.

Two Huge Bucyrus Shovels

The surveys for the work were begun in 1914 and continued for nearly two years. During the year 1917 the construction plant was brought onto the job and assembled, and during the first part of this year the camps were nearly completed. At the present time the only rock that is being taken out is at the forebay and the only earth that is being moved on the excavated section is at the Whirlpool, but a start will be made in a few days on excavation at other points. Eight hundred men are now at work.

The main equipment for the earth and rock excavation consists of two very large electrically driven, revolving, Bucyrus shovels, fitted with an eight-cubic-yard bucket for excavation in dirt, and of capacity to handle

a five-cubic-yard bucket in rock. The boom on No. 1 shovel is 90 ft. long, and the dipper stick 58 ft. The boom on No. 2 shovel is 80 ft. long and the dipper stick 54 ft. Either shovel can load dump-cars which stand on a track the level of which is 62 ft. above the level of the tracks on which the shovel stands. The shovel rests on two tracks (four rails) and is mounted on sixteen wheels. The tracks are 30 ft. centre to centre. The nominal horse-power of each of the two shovels is 715 h.p. upon a half-hour intermittent rating. Each shovel weighs over 400 tons, contains 75 tons of ballast, and has a capacity of 3,000 cubic yards a day when handling earth. At the present time No. 1 shovel is working at the Whirlpool against a face 100 ft. high. It is said to be the largest electrically driven shovel in the world, working against the highest face excavated on work of this character.

There are also five other electrically driven shovels at work, each having a ⅞-yard bucket.

Powerful Construction Equipment

At the Welland River section of the canal, a Lidgerwood cable excavator is at work, fitted with a three-cubic-yard Andreson-Evans clam. The cableway has an 80-ft. head tower and a 60-ft. tail tower, and has a span of 800 ft. The excavated material is being disposed of along the north banks of the river. The width of the Welland River at the water line averages about 300 ft.

The commission has purchased one hundred and fifty 20-yard Western air dump cars, each of 80,000 pounds capacity, six 40-ton steam locomotives and twelve 50-ton electric locomotives. The steam locomotives are switchers purchased from the Pennsylvania Railroad. The electric locomotives were built by the National Steel Car Co., Limited, of Hamilton, Ont., six of them being constructed with General Electric equipment and six with Westinghouse equipment. Two pile-drivers are at work on the river section. There are three 40-ton and two 15-ton Bay City locomotive cranes for general utility work. Drag-line excavators may be purchased at a later date to clean the sloped banks of the overburden which cannot be reached or smoothed down so advantageously by the shovels, or the locomotive cranes may be rigged up for the purpose.

It is estimated in round figures that 9,000,000 cubic yards of earth and 4,000,000 cubic yards of rock must be removed from the excavated section; and from the river section, 2,000,000 cubic yards of material, mostly earth.

Disposal Area at St. David's

At the present time tbe material which is being excavated from the Whirlpool section is being used to fill the old Whirlpool gulley, but the main dump will be at St. David's. A double-track railway line has been built for the full length of the canal from Montrose to the forebay, and a branch extends to the St. David's dump, two miles away. There will be various other branches of the railroad constructed from time to time as needed. A railway will probably be built from the power house to connect with the Michigan Central at Queenston to bring in the machinery and to take out the material excavated from the power house substructure.

The dump cars drop the material alongside the track and two Jordan spreaders are used to shove it back over the embankment.

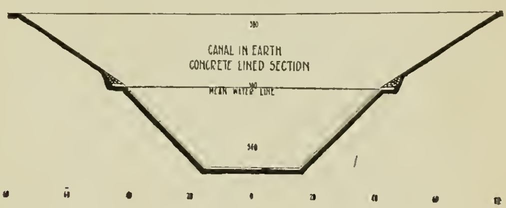
The railroad lines are all electrified, the trolley wires being offset on one side of the track, and carried in clamps devised by the commission's line construction department. These clamps and the hangers which suspend them from the poles, are all made up of standard material, and are so arranged that the temporary use of the material does not injure it. A number of timber trestles are set alongside the temporary tracks and carry the trolley wire for those tracks. These trestles are mounted on four wheels and can be hauled right onto the track and pulled away readily by a steam locomotive when the track is to be moved.

The commission has its own telephone water and electric light systems, and has private, direct telephone communication from the Whirlpool to the head office on University Avenue, Toronto.

Splendidly Equipped Sub-Station

No. 1 sub-station is located at the Whirlpool. The power comes into the station from the Ontario Power Company's plant at 12,000 volts and is stepped down to 4,000 volts by three Canadian General Electric transformers, each of 1,500 k.v.a. capacity. The power is distributed up and down the canal at 4,000 volts. Westinghouse and Maloney transformers step some of the power down from 4,000 to 440 volts for use by the shovels. Three rotary converters, each of 500 kw. capacity, convert some of the power to 600 volts d.c. The station is equipped with most modern appliances in the way of switches and other apparatus, the electrical equipment costing about $110,000.

At this sub-station there are now erected, ready for operation, four Sullivan belt-driven air compressors, each



of 1,000 cubic feet per minute capacity against 125 pounds pressure. They are belt driven from Canadian General Electric 550-volt motors, 180 amperes, 750 r.p.m. As the work progresses, eight or ten more compressors will be installed at this station. All the rock drills, channellers and forges, and much of the other equipment, will be driven by compressed air. The air is piped up and down the canal for three miles in each direction, the mains leading from the sub-station being 10 inches in diameter, reducing to 8 inches and 6 inches. Another sub-station will be built near Montrose and more compressors will likely be installed there.

In the Whirlpool yards is located a large machine shop containing drills, shapers, planers, lathes, forges, trip-hammers and wood-working machines. The commission has built about eighty buildings, including bunk-houses, freight-house, offices, machine shop, store-houses, sub-station, etc. Also a number of buildings are used which were on various parcels of purchased property.

Buildings are Being Gunited

Most of the buildings are of frame construction, but are being gunited on the outside over tar paper and wire mesh, using 1 to 3 mix of cement and sand. Sharp concrete sand is being used and the gunite applied by cement-guns. The sub-station, machine shop and all of the more important buildings have already been fire-proofed and weather-proofed in this manner, and it is

the intention to gunite most of the other buildings. The bunk-houses are comfortably arranged upon the cottage plan. Each house has its own garden plot, which the men take care of during the evenings.

The crushing plant is located on the forebay. At the present time there have been erected three gyratory crushers, two No. 7's and one No. 7½, but in the Montrose yard are now the parts for a great 84-inch Traylor jaw crusher which will be erected this summer, and which will have a capacity of 20,000 cubic yards of crushed stone per day. Whether much of the rock will be dumped at St. David's, or whether it will all be crushed for sale to the general public, is a matter of policy that will be determined by the commission.

Building Four Concrete Bridges

The rock will all be drilled with Ingersoll-Rand and Sullivan rock drills and blasted with dynamite. C.X.L. brand, 40% and 60% has been used to date. The rock will be loaded onto the dump cars by steam shovels. At the present time the rock excavation at the forebay is on a very small scale, the stone being quarried merely to provide aggregate for concrete work and to supply ballast for the railways. The rock is loaded into skips which are picked up by a locomotive crane and which dump into a bin. A belt conveyer carries the stone from the bin to the crushers, and there is another conveyer from the crushers to the cars.

The concrete work for which the rock is now being used is in connection with a number of bridges which must be built by the commission. There are four railway bridges to be constructed over the canal, one for the Niagara, St. Catharines and Toronto Railway (electric), one for the Wabash Railroad, one for the Michigan Central Railroad and one for the Grand Trunk and Michigan Central Railroads.

These will be reinforced concrete arch bridges, 36 ft. to 38 ft. in width, 100 ft. clear span. There will also have to be constructed a number of highway and foot bridges to carry the various roads across the canal. In the concrete work to date, both Canada and St. Mary's cement have been used.

Hydraulic Similarity Models

Under the direction of Prof. R. W. Angus, of the University of Toronto, several hydraulic similarity models are being prepared at Dufferin Islands, near the Ontario Power Company's intake in the Niagara River. These models are based on designs prepared by the commission and are for the purpose of studying the conditions at the intake. The design of the intake works will be based upon the results of these studies. The models are being made to a 1/20th scale.

Personnel

Hon. Sir Adam Beck is chairman of the Hydro-Electric Power Commission of Ontario, the other commissioners being Hon. I. B. Lucas and W. K. McNaught, C.M.G. W. W. Pope is secretary, and Frederick A. Gaby, under whose direction the entire work was planned and is being constructed, is chief engineer.

The design and construction of the project are under the direction of the Hydraulic Department of the commission, as were also the studies and surveys for the scheme. Henry G. Acres is hydraulic engineer; Thomas H. Hogg, assistant hydraulic engineer; and Max V. Sauer, the department's designing engineer. E. T. Brandon is electrical engineer.

There is a large staff of engineers and construction superintendents and foremen at Niagara Falls under the direction of J. B. Goodwin as works engineer and of George Angell as general superintendent. A. C. D. Blanchard is field engineer; F. W. Clark, assistant field engineer; R. T. Gent, plant engineer; William Snaith, office engineer; W. S. Orr, resident engineer on Division No. 1 (Welland River section); and George Lowry, resident engineer on Division No. 3 (station 235 to station 438+33, where the forebay begins). No construction work has been done yet on Division No. 2 (from the Welland River to station 235). To date, Mr. Orr has been acting as resident engineer on any work done on Division No. 4 (power house, gatehouse and forebay).

F. W. Scriven is division superintendent on Division No. 3, and C. Anderson acting superintendent on Division No. 1. Nos. 2 and 4 division superintendents have not yet been appointed. Harold L. Bucke is superintendent of railway construction; E. M. McGivern, mechanical superintendent; F. F. Cooper, chief clerk in charge of the accounting, cost-keeping and time-keeping systems.

LESSONS OF THE WAR AS APPLIED TO ROADS AND BRIDGES*

By Walton Maughan

ONE of the revelations of the war is the way in which bituminous-bound or tarred or even ordinary macadam—especially when laid over good foundation layers of Telford pitching—"stands up to its work." More than this need not be said to the able macadam enthusiasts in charge of the rural roads of this country.

On *pavé* roads through or near numerous towns in Northern France and Belgium there may be differences of opinion as to its merits as a lasting surface, but motor and horse transport drivers and hapless pedestrians agree that these merits are more than counterbalanced by its unevenness of contour, its irregularity in wear, causing excessive vibration and noise, and its treacherous slipperiness in dirty weather as compared with good macadam. It is surprisingly common—often in short strips—in lanes and by-roads of minor importance as well as on sections of the great routes nationales.

Footpaths

Regarding footpaths for rural main roads the writer will only state that while he was district road surveyor—(pardon, "inspector")—for the Coventry district of Warwickshire there was added to those roads bearing the heaviest motor traffic an aggregate length of footpaths which in a few years amounted to about 15 miles. For over half of this distance all that was necessary was an opening out of overgrown old-time tracks, and a covering of clinker ashes and screenings. The cost was negligible, for much of the cartage of turf and soil was done free by the farmers of the adjoining land to which this compost was applied during the winter months.

Classification of Road Materials

Such systematic study of the effects of road traffic as I have ventured to plead for naturally brings into prominence the classification of road materials, and particularly road stones, and the urgent necessity for stand-

*Abstracted from a paper read at a meeting of the Institution of Municipal Engineers.

ardizing other elements or substances used in road construction. This is the special province of trained geologists and chemists who ought to be put in charge of a department constantly engaged on this vital work of investigation and research.

At the present day we have very little practical experimental data to go on, and even the far-seeing pioneers —such as Mr. Lovegrove and others—who have undertaken such work on a necessarily limited scale have been handicapped by the absence of actual tests on roads bearing different classes of traffic as shown by a scientifically planned traffic census.

This last method is, the writer suggests, the only sure test of a road stone; but the help of such experts as are suggested will become increasingly necessary as the work of road construction becomes more complex and bituminous and other products play a larger part in our work than hitherto. But even our present-day knowledge would—were it only applied—prevent firms advertising as "granite" numerous classes of road stone as distinct from granite as well-defined classes of rocks can be, both from a geological and a business or commonsense point of view.

Such "annexationists'" material is generally vastly inferior to the best-known granites used on our roads. One instance the writer can give, for he condemned some hundreds of tons of defective material from certain particular quarries, which at the best turn out a second-rate road stone (a quartzite) quite suitable for local district roads, but which lasted less than one-third the life of a good granite stone from quarries in an adjoining county, but equally near at hand. And yet to-day we have millions of tons of stone sold as granite and described as such on their letter paper and literature by firms who do not hesitate to try any means to "down" any surveyor who has the temerity to point out that they cannot produce one single ton of granite from their quarries, or to crush between fingers and thumb quantities of "top-stuff" sold as granite with a crushing strain of —— thousands of lbs. pressure per square inch!

Verily our institution has a future, if only in battling against such real corruption—a work which, coupled with our defence fund, is worthy of our best efforts—another battle in which the writer is determined to again "do his d—ndst." And he would venture to pass on to his colleagues in the defence of our rights that time-worn maxim of war, "The best defence lies in attack."

Wanted—"Business Methods"—and an Organizer

And as constructive, rather than carping criticism is the *motif* for these remarks, I venture to throw out the suggestion that a really able and tactful inspector of contracts (annual and other) should, with the assistance of a small expert staff, be able to save the country possibly £100,000 yearly on that half of the total road expenditure (say, £10,000,000) which is expended on material, etc., and which could thus be brought under review for the purpose of a "business" or "quality" audit, as distinct from that mere checking of figures usually subject to those really infantile "deductions" of the Local Government Board. How? (1) By backing up every surveyor, especially at those meetings of his authority when the large annual contracts are let; (2) by inspecting materials on the roads—before, during, and after use thereon—by organizing and checking transport and haulage, and generally by applying those business principles and that wholesome supervision upon which every really successful business organization is built up, extended, or modified as is necessary to meet the complex difficulties every worthy contractor, no less than each surveyor, has to battle against almost every day.

One result of such appointments would be to increase the output of practically every single class of usable road material, and, though insisting upon uniformity and excellence of material would naturally result in increased business to the firms producing such materials, the only people who would be "ousted" would be those retailers of local dumps of materials which experience proves to be worthless for use even on adjoining roads. On the other hand, a good local material should "oust" material from a distance which is no better for the required purpose. Again, the organization of methods of delivery and of transport should result in enormous economies being effected; and in this connection why not prepare to use some thousands of our war-time motor vehicles—in helping to balance "supply" and "demand" in this public service after the war? All this—and more—should be the task allotted to a really "live" man trained in the severe school of experience to distinguish real organization from its shadow.

Road Rollers

Having regard to the necessity for true downward pressing together of present-day bituminous road materials rather than the uneven tangential stresses of wheeled rollers, the writer has designed both steam and motor-engined road rollers on the "Tank" principle, but as he does not consider he has yet fully mastered all these lessons, the less teaching of half-truths the better.

Bridges

As regards new points *re* bridges and bridge construction brought out by the war, many pages could be written from the military point of view, but were it permissible to publish even a résumé of all the facts interesting to us as road engineers, this phase of our common interests would alone provide the subject-matter for several papers more technical than this "summary of lessons" is intended to be.

The first essential of a bridge which has to carry modern traffic is width, and this point has been already emphasized to the best of my ability. And whether for extending lengthwise those countless culverts and small-span arches, or for filling up behind the haunches of those "hog-back" bridges, which alike seriously detract from the utility of our highways, there is, I consider, no one material to compare with ferro-concrete. In fact, the one outstanding lesson as to materials of construction taught by the war is, in my opinion, the all-round excellence from all points of view of concrete, and more especially ferro-concrete construction.

Ferro-concrete bridges are practically indestructible, as the war has well proved. Not only do they bear the downward stresses they were built for, but they stand the lateral and upward stresses from explosions and floods better than bridges of masonry, etc. Even in England we have had the parapet walls of narrow bridges pushed off by ordinary traffic, whereas ferro-concrete will stand up against almost anything.

In the forthcoming directory of the American Association of Engineers, there will be an innovation in the way of a classified list separated into the several branches and specialties of engineers. For instance, under the electrical engineering division will be sub-heads of members who have had experience in the design, inspection, test or sale of batteries. In the base or main list, which will be alphabetical regardless of grade, the full service record will be given, so that the directory becomes a guide to the employer of engineers and a silent salesman for the individual.

ROAD DRAG COMPETITION

RULES for the road drag competition for the year 1918 have been announced by the Saskatchewan Roadways Department. One important innovation will be noticed. The automobile clubs and good roads associations of the province, which have already done so much for the promotion of good roads, are now, at their own request, being invited to take a practical part in the work of maintenance by entering the competition on the same terms as the rural municipalities.

Rules Governing the Road Drag Competition, 1918

1. The competition is open only to the councils of organized rural municipalities, duly affiliated automobile clubs and duly organized good roads associations. Entrants will be grouped together in such manner as to form districts with from ten to twelve competitors each.

Dragging started officially on June 1st and will end September 30th.

2. Only one entry will be allowed from each municipality, automobile club and good roads association. The entry of automobile club or good roads association must be accompanied by the approval of the municipality in which they are located.

3. The road to be entered must be at least two and no more than six miles long.

4. Any road which was entered in one of the former competitions will not be accepted for entry this year.

5. Roads entered in the competition must be a continuous grade. New roads to be built this year will not be accepted for entry. Roads graded in former years may be regraded and will then be eligible for entry, but such regrading must be finished prior to June 1st.

6. Every competitor is to put a sign on each end of the road bearing the following legend: "This road is entered in this year's road drag competition."

(The Department of Highways will supply, free of charge, to such competitors as apply for same, the necessary signs printed on heavy cotton.)

7. The competing roads must be kept clear of weeds and all manner of growth from ditch to ditch, very short grass between grade and ditch excepted.

Must Make Monthly Returns

8. Returns on forms to be furnished by the Department of Highways must be made regularly every month, and not later than on the date printed at the bottom of the form. They must be filled in complete by both operator and secretary. If the returns are withheld until the end of the competition and then sent in a bunch, or if no returns at all are sent, the competitor who in such manner disregards this rule will be disqualified thereby.

9. The prizes to be awarded in each district will be as follows: First prize, $150; second prize, $125; third prize, $100; fourth prize, $75; fifth prize, $50.

10. The roads of the first prize winners in all districts will be inspected again after the regular prizes have been awarded, and of these roads the one that is adjudged best will receive a grand prize of $250, the second best will receive a grand prize of $150, and the third best a grand prize of $100.

11. All the above prizes will be paid in the following proportion: 75 per cent. to the competitor winning a prize and the remaining 25 per cent. to the winning operator. This applies to both regular and grand prizes.

12. The competitive roads will be inspected from time to time during the season, and the condition of the road at the time of entering, the character of the soil, the amount of traffic and other general conditions affecting it, and the state of the road during the season and when the competitions close, will be taken into consideration in awarding the prizes.

13. The judging will be done by points and the awards of the prizes will be made by disinterested judges appointed by the department, the decision of the judges being final.

14. Roads will be judged along the following lines: 1, Condition of road before dragging starts; 2, nature and formation of soil; 3, length of road. During season: 4, improvement of road in (*a*) crown, (*b*) hardness, (*c*) smoothness; 5, condition of ditches; 6, freedom from weeds; 7, general appearance. End of season: 8, value of returns.

15. No withdrawal of a road will be accepted after June 1st, 1918.

GOOD ROADS ASSOCIATION FOR OTTAWA

ANNOUNCEMENT has been made that in the very near future an Ottawa and District Good Roads Association will be launched. In view of the increase in motor traffic and the success which has attended the Ottawa Motor Club, it is thought that the time has arrived for the organization of a district association whose main object will be the promotion of good roads in that section. So far, most of the responsibility in this connection has fallen on the shoulders of the Ottawa Motor Club officials. In Western Ontario and other parts of the country there have been formed, in addition to the automobile clubs themselves, associations which must link up with autoists in encouraging the work of road construction and maintenance. Ottawa has determined to follow the example of her western friends and the suggestion was discussed last week by President Ahearn, Vice-President Jarman and other officers of the Ottawa Motor Club.

Farmers from the surrounding district will be invited to take part as they, too, will share in the benefits accruing from the policies of road improvement to which the Ontario and Quebec governments are committed.

What is said to be one of the largest hydraulic turbines yet built, is to be installed by the Hydraulic Power Co., of Niagara Falls, N.Y. The normal operating conditions for which the turbine has been designed are as follows: Heads from 213 to 214 ft.; speed, 150 r.p.m.; discharge, 1,500 cu. ft. per second; capacity, 37,500 h.p. The turbines which will be built for the Chippawa development on the Canadian side of Niagara, will have a capacity of 50,000 h.p., but will operate under higher head.

There is urgent need for a definite stocktaking of the commercial timber and pulpwood now available. Mathematical accuracy is not essential, but sufficient cruising and gathering of data should be completed to permit of reliable estimates being made. Such work has already been done by the Commission of Conservation in British Columbia. Similar work will be done in Ontario as soon as the funds are available and the necessary organization has been completed. Then, too, the provincial government of New Brunswick is engaged in making such a survey. As yet, however, only a partial methodical stocktaking has been made of the available pulpwood supplies of Quebec. Quebec has, however, the most important pulpwood area in Canada. The transportation facilities of the province, both natural and artificial, are excellent for the delivery of pulpwood and pulpwood products on the important markets in America and England.

Reconstruction of Devastated Halifax

Under the Leadership of Canadian Engineers and Contractors, Splendid Maritime Port Recovers Rapidly From the Terrible Effects of the Mont-Blanc Explosion—Description of Relief Organization and Methods

WHEN the Belgian Relief boat, "Imo," collided with the French munition ship, "Mont Blanc," in Halifax Harbor at 9 a.m., December 6th, 1917, setting on fire the Mont Blanc's deck load of benzine and resulting in the explosion of her cargo of 4,000 tons of trinitrotoluol, about 2,000 residents of Halifax were killed and 5,000 injured; 3,164 houses and factories were totally destroyed and over 6,000 houses were damaged, the total property loss being $25,000,000.

That such enormous havoc could be wrought without creating vast engineering problems, seemed inconceivable; so after allowing plenty of time to elapse, in order not to interfere in the slightest degree with the all-important work of rehabilitation, Halifax Relief Commission officials were asked to co-operate in the preparation of an article covering the engineering features of the work of reconstruction.

"There is no engineering of any magnitude in this work," said Col. Robert S. Low, the manager of reconstruction. "It's merely a mess of details,—broken windows, fallen chimneys, tottering houses, debris to be carted away, temporary houses to be provided and a hundred and one other detailed jobs of that sort; but nothing of special engineering or contracting interest."

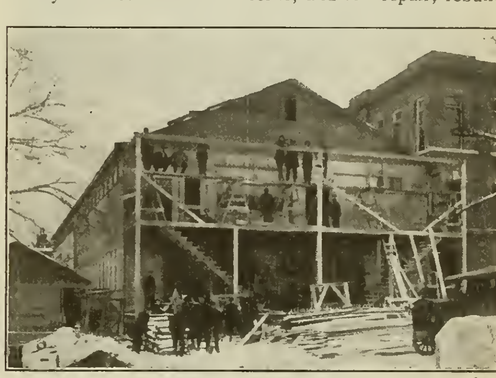
A thorough inspection of the city and surrounding district substantiated Col. Low's summing up of the situation in all but one particular: the splendidly organized system of handling this "mess of details" would interest any engineer or contractor whose average labor consists

The Foreground was Covered with Houses and Stores Before the Explosion, which Occurred at Almost the Exact Centre of this Photo. Beached Across the Narrows can be Seen the Belgian Ship "Imo"

not in the carrying out of extraordinary and unique jobs but in the successful and efficient organization of just such routine details.

Powers of Relief Commission

In view of the magnitude of the relief needed after the accident, and the rapidity with which it had to be afforded on account of the severity of the weather, there was organized a Relief Commission which later was permanently incorporated by the provincial House of Assembly. Should any member of the commission die or resign, the Governor-General is to appoint the successor. The act gives the commission power to expend as it sees fit all money donated for Halifax relief, and to "repair, rebuild



Model Labor Camp

or restore buildings or property damaged, destroyed or lost in the explosion; or compensate the owner to such an extent as the commission thinks fit." Portions of the money subscribed may be set aside for the maintenance, support and education of victims of the disaster, and for the aid of institutions or associations interested in the work of relief.

Regarding reconstruction, the act provides that the commission shall exclusively have such powers as has any city, town or municipality by virtue of the Town Planning Act of 1912. The commission is authorized to lay out and open any new street in the devastated area; to widen, straighten, alter or extend any existing street; to remove the whole or portion of any building, wall or fence; and to raise or lower the level of any street. No action may be maintained against the commission or its officers for any injury occasioned to any property. The commission is empowered to open the soil of any street in the devastated area for any purpose, notwithstanding anything contained in the Halifax City Charter. Any new street opened by the commission shall be considered a public street or road. This also applies to streets widened or otherwise improved.

While the act provides that the commission shall have power in the devastated area to divert any public or private sewers and to connect with the sewer system of any city and not be liable in any action therefor, the provision is made that in doing so the commission shall do the work in conformity with the sewerage system of the city. Power is given to the commission similarly with regard to water supply and hydrants.

Any land which the commission may think fit for its requirements, whether this land is in the devastated area or not, may be expropriated, and provision is made for the appointment of arbitrators.

The commission may from time to time describe, delimit and define any part of the city of Halifax, the town of Dartmouth or the county of Halifax as the "devastated area." The commission may also from time to time alter, enlarge, restrict or in any way change the area so defined by giving proper published notice to the public.

These Temporary Relief Apartment Houses Were Completed at the Rate of One Apartment an Hour

Organization of the Relief Commission

T. S. Rogers, K.C., is chairman of the Halifax Relief Commission, the other members being Judge W. B. Wallace and F. L. Fowke. The work of the commission is divided into two distinct divisions, rehabilitation and reconstruction, the former department dealing with the physical and financial welfare of the victims of the disaster, while the latter department attends to all matters involving buildings or property. Col. R. S. Low was manager of the reconstruction department until June 1st, 1918, when he resigned, having told the commission last January that he would be able to stay only until May. He was succeeded by Geo. Archibald, of Toronto. Ralph Bell is the secretary of the commission, and H. W. Johnston, acting city engineer of Halifax, is consulting engineer. Col Low attributes a very large share of the credit of the work accomplished to Mr. Johnston, who was an indefatigable worker.

Offices of Relief Commission

Immediately after the disaster, Col. Low opened reconstruction offices at the Halifax Hotel. After the more immediate needs of the situation had been met, and when there had arrived sufficient materials to spare some for the purpose, he built two temporary frame and beaverboard office buildings for the use of the Relief Commission. While classed as temporary structures, these buildings—which were erected and furnished complete in seventeen working days, by the way—are very substantially constructed and will no doubt serve the purposes of the commission for several years. These buildings, and also the mess kitchen and staff quarters were built for the commission gratuitously by the firm of Bate, McMahon & Company.

The two buildings are exactly alike and are connected by a hallway. One is occupied by the reconstruction department and the other by the rehabilitation division. The buildings are each 41 ft. x 96 ft., placed 30 ft. apart. They are two stories in height.

The Reconstruction Building provides offices on the ground floor for the purchasing agent, invoice clerk, general superintendent, district superintendents, manager of reconstruction, acting city engineer, statistical clerks, stenographers, time-keepers, accountants, employment agents and transport clerks; and on the upper floor for the chairman of the commission, Secretary Bell, Commissioner

Halifax Relief Commission's Offices

Map of Part of the City of Halifax, Indicating the Destroyed Area. The "Mont Blanc" was Between Piers 6 and 8 When Her Cargo Exploded

Fowke, engineers and draftsmen, office staff, telephone and telegraph operators, post office employees and appraisal board and staff. In this building is also the general board room.

The Rehabilitation Building houses the medical, social service, food, records, finance, military housing and stationery departments, and Commissioner Wallace. Also in this building is the court room where evidence is heard regarding claims, and where claims for small amounts are promptly disposed of if properly presented and proven.

System in Reconstruction Office

All requests for repairs or reconstruction go first to the general office in the reconstruction building, and are usually handled primarily by the reconstruction manager. Unless there is apparent attempt to defraud by claiming repairs to which the applicant is not entitled, or other reason for special treatment, a memorandum of the application is passed on to the inspection department for report. There are specially qualified inspectors for the various kinds of work required; that is, chimney inspectors, sanitary inspectors who work under the direction of the city's board of health, etc. An inspector promptly visits the given address and reports on the nature and actual extent of the damage, its cause, probable cost of repair, probable time required for repair, and exact amount and size of materials needed. This report in triplicate goes back to the general reconstruction office, and if approved, one copy is fyled, another copy goes to the records office, and the third is sent to the district superintendent in whose territory the work happens to be.

Halifax and its surrounding territory are divided into ten districts, each in charge of a superintendent who has a staff of plasterers, carpenters, masons, etc. Each district has its own headquarters centrally located within the district, also its own carpenter shop, storehouse and toolroom. There is also a general warehouse from which materials are requisitioned by the districts, and to which all materials are originally delivered.

After the final repairs on, say, John Smith's house, 411 Main Street, have been completed, the district superintendent reports the time and materials used, and this information is compared for checking purposes with the

Typical View of Streets Bordering the Devastated Area

estimate previously made by the inspector, and if reasonably O.K. it is entered on a card as illustrated below.

The third column of the card below indicates where further details about each item may be found. "R.R. 1203," for instance, refers to account No. 1203 in the temporary repair records card index. P.R. is the code for permanent repair records; C.R., chimney repairs; W.R., wiring and roofing; S.R., sanitary repairs; G.R., gas repairs; X, special records. These more detailed records are entered on cards in the manner indicated on the following page.

These, of course, are merely the cost and material records and are, in turn, supported in further detail by receipts, requisitions, etc., the whole system being as thoroughly detailed, cross-indexed and "fool-proof" as is possible without involving red tape which would delay the

Main St. *No.* 411 **PERMANENT REPAIRS** John Smith *Owner.*

WORK	DATE	NO.	COST	REMARKS	Total Cost
Temp. Repairs		RR1203	$104.50	Mat. del. by Relief Com. #1217—$32.40	$136.90
Shoreing	3-2-18	RR1505	37.90	Jacking in side of house	37.90
Mason	10-3	PR302	18.00	Foundation	18.00
Chimney	6-1	CR201	25.53		25.53
Glazing	15-1	161	50.50		50.50
Carpenter					
Roofing	14-3	WR300	20.70		20.70
Plumbing	7-1	SR35	10.72	Mch. 10-18 Brown's final bill $30.20	40.92
Heating	15-3	X91	21.70	Jones Ltd. Bill	21.70
Electric	14-3	WR300	17.50		17.50
Gas	4-3	GR25	7.40		7.40
Plastering	23-3	PR340	51.50		51.50
Painting	30-3	PR400	30.20		30.20
Papering	1-4	PR450	15.75		15.75
Barn	11-2			Owner to repair	
				TOTAL	$474.50

work; in this connection, bearing in mind that a large number of these repair orders were of very urgent character.

All systems in the general office are reduced to the simplest form consistent with affording a complete analysis of every expenditure and the rapid finding of any item of expenditure under any heading—type of work, name of owner, or street address. The book-keeping in regard to labor, and the preparation of pay-rolls, etc., are mostly done automatically by specially devised adding and listing machines of large size.

Daily Material Inventory

The vacant plant of the Nova Scotia Car Works was seized by the commission as the general warehouse. Each day the warehouse superintendent makes a report to the general office of the incoming material, outgoing material and stock on hand. The incoming material reports for several months were each made up of from fifty to two hundred or more items such as the following:—

Ex. car No. 152708	10 Wasp ranges
	90 bags cement
	14 wooden benches
The Barrett Co.	190 rolls 2 ply roofing
	2 casks green stain
Brandram-Henderson	2 bbls. green stain
	2 bbls. brown stain
	20 gals. varnish remover
Imperial Oil Co.	4 bbls. gasoline
	5 bbls. coal oil
Stairs, Son & Morrow	6 kegs 4" wire nails
Etc., etc.	

The daily stock sheet is arranged alphabetically and generally contains about 350 items such as the following:

Bath tubs	139
Beaver-board, sq. ft.	152,920
Benches, wooden	20
Brick, cars	1½
Cement, bags	750
Coal, cars	2
Hammers, claw	64
Kitchen sinks	350
Lumber, 1" rough spruce boards	57,436
Lumber, 2" rough planks	11,526
Lumber, 3" rough deal	47,442
Etc., etc.	

These stock lists include all manner of building materials, either bought or contributed. For instance, the stock list of March 10th, 1918, included various sizes and kinds (the quantity of each and kind being separately reported) of axes, bath tubs, beaver-board, benches, blocks, bolts, boilers, Bon Ami, bowls, braces, brick, brooms, brushes, carbide, cement, church bells, clay, closet bolts, clothes lines, coal, copper, cord, crowbars, dampers, disinfectant, doors, dry cells, extinguishers, files, gasoline, glazier points, globes, glue, grease, hammers, handles, hasps, hea'ers, hinges, hooks, hooks and eyes, jars, keys, kitchen sinks, knives, knobs, ladders, lanterns, latches, laths, lead pipe, levels, lifts, lime, locks, lumber, nails, oil, pails, paint, picks, pins, pipe, plaster, pliers, powder, pulleys, roofing, rope, sand, sand paper, sash weights, saws, scrap lead, scrapers, screw drivers, screws, sets, sheathing, shellac, shingles, shovels, snips, soda, stain, staples, stove pipe, strainers, tape measures, tar, tarpaulins, tins, turpentine, twine, valves, waste bales, wheels, whitening, wicks, wrenches and zinc.

Separate Glass Warehouse

The greatest demand for weeks after the explosion was for plate glass and ordinary window glass, as practically every pane in Halifax and Dartmouth was broken, and most of them were blown out entirely. The explosion was followed by a severe blizzard and very cold weather, and there was acute suffering until the windows were replaced or boarded up. A separate glass warehouse was established where the various sized panes were kept in racks and were cut to exact measurements before being sent to the different jobs, so as to avoid all waste. Glass was purchased twenty carloads at a time. The local dealers were cleaned out in a day, and soon so was every dealer in St. John, Sydney, New Glasgow and other cities in the Maritime provinces. One of the earliest relief shipments from Boston, Mass., was half a shipload of glass. Most

1203RR		**TEMP. REPAIRS**	
Main St. 411		#6 Dist.	John Smith
#432	20-12-17	Inspect and repair house - -	$ 8.90
	24-12-17	RR340 Gl. B.B. &c.	21.40
	26-12-17	RR569 carp. -	28.60
#690	3-1-18	Repair Roof and Plumbing	
#732	30-1-18	Shore up house and further repairs needed	
	5-3-18	Carpenter and Glazing RR900 -	45.60
			$104.50

302PR		**FOUNDATION**	
Main St. 411		#6 Dist.	John Smith
6-3-18	13 h., 50c. $6.50		
	13 h., 30c. 3.90—10.40		
	8 Bags Cement 6.00		
	16 " Sand 1.60— 7.60—$18.00		

201CR		**CHIMNEY**	
Main St. 411		#6 Dist.	John Smith
6-1-18	Masons 20 h., 50c.—10.00		
	Lab'rs 20 h., 30c.— 6.00—$16.00		
	375 Bricks $5.63		
	2 Bags Cement 1.50		
	6 " Sand 1.20		
	2 " Lime 1.20 —		9.53
			$25.53

of the glass came from West Virginia, Ohio and Pennsylvania, from a score of manufacturers.

Model Labor Camps

In answer to the call for help that went broadcast at the time of the accident, workmen were sent to Halifax from many parts of Canada and the United States. For several months the number of men employed was very large, totalling at times about four thousand. Most of

the large buildings which were situated advantageously for use as camps, had been wrecked, so one of the first things that Col. Low had to do was to erect camp buildings. Two camps were built of the type shown in the accompanying illustration, and other camps were established at the curling rink and at the new Alex. McKay school. These camps are all very sanitary and clean; with large, comfortable mess halls, shower baths, porches and fire-escapes. The bunk rooms are well ventilated and kept remarkably well deodorized.

Each camp superintendent reports each evening on the number of workmen in camp that morning, the number received and discharged during the day, the number in camp that evening, the number of unoccupied bunks, the check numbers of the men received or discharged, the number and occupation of the camp employees, the check numbers of the men who are sick or lying in, and the number of meals served at breakfast, dinner and supper time. The report of the Alex. McKay school camp for March 10th, for instance, showed 1,609 in camp in the morning, 16 received, 12 discharged, 195 unoccupied bunks, 89 employed on camp duties, 4 sick, 1 lying in, 1,330 breakfasts, 1,448 dinners and 1,558 suppers.

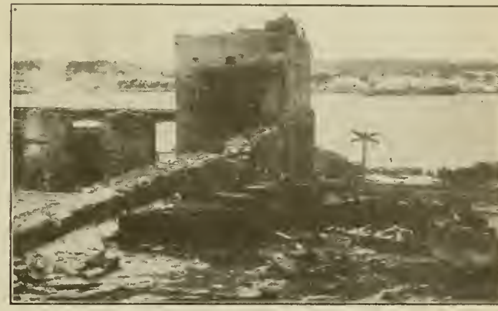
Not Rheims nor Lille,—Just Halifax, After the Explosion. Ruins of St. Joseph's Church

The camps have a medical inspector, Dr. V. A. Miller, who reports daily on the number of men sick and not working, the number examined and treated, and the number in hospital.

Every foreman and superintendent reports daily the number of men at work and their check numbers, and this is summarized in a report to the general office showing how many men in each trade are at work under each superintendent, and a list of the jobs which each superintendent is handling. The report of March 9th, which is typical, showed 3,299 men at work, comprising the following:—

Blacksmiths, 4; bricklayers, 180; carpenters, 1,017; chauffeurs, 39; checkers, 22; clerks, 29; commissary, 163; engineer's staff, 5; estimators, 2; foremen, 150; glaziers, 160; handymen, 111; helpers, 2; inspectors, 8; laborers, 609; masons, 5; mechanics, 17; mill men, 36; office staff, 43; operators, 3; painters, 275; pipe fitters, 8; plasterers, 132; plumbers, 107; policemen, 18; roofers, 8; shippers, 2; stablemen, 4; storekeepers, 8; superintendents, 24; teamsters, 77; timekeepers, 21; watchmen, 10.

Daily reports are sent to the general office by the inspector of each trade at work. The painting inspector reports on the status of each painting job, the plumbers report their progress, and so do the electricians, carpenters and all other basic trades. In addition to studying these reports, much of the work is personally visited each day by the manager and assistant manager of reconstruction and by the general superintendent, while each district superintendent visits every job in his district.



Ruins of a Warehouse—"Imo" Beached Across the Narrows

Daily report is also made of the men who have given notice that they are leaving the employment of the commission. This report takes the following form:—

No.	Name.	Occupation.	Cause.
473	Fisher, Harry	Carpenter	Wife sick
499	Marhian, L.	Bricklayer	Drafted, M.S.A.
672	Aspirat, P.	Glazier	To go on farm
2133	Rawle, C.	Carpenter	Broken ankle
Etc., etc.			

Tab Kept on Teams and Motors

Equally accurate record is also kept of the teams employed. A daily report is made showing who ordered the team, who was the owner of the team, number of hours used, number of loads carried, where loads were obtained, where loads were delivered, character of load, team number (under commission's system of numbering) and name of driver.

Interior of New Alex. McKay School was Wrecked—Walls Bulged and Reinforcing Almost Blown Out of the Concrete in Places

Similar reports are made daily for the motor trucks, and also a garage report showing the number and make of each truck in service and what condition it is in. The garage also reports in this manner on the touring cars in service.

To prevent the use of the touring cars for private purposes, a very detailed touring car report is presented daily, showing just who has used each car and for what purpose it has been used every minute of the day. A summary at the end of the report shows how many total hours each person has used autos, how many cars were in service, the total number of people who used them and the total time for which they were used.

General Summary of Reports

All daily reports of repair work, labor, teams, trucks, etc., are summarized in a daily general report to the manager of reconstruction. The following is a typical example of this general report:—

Report of Repair Work Up To and Including March 17th, 1918

Number of requests made for general repairs	5,397
Number of houses temporarily completed	5,945
Number of repairs completed to soldiers' homes by the Military Housing Committee	152
Number of barns and stable repairs completed	68
Number of houses reported on by city engineer and listed for permanent repairs	3,694
Number of permanent repair jobs in progress	1,527
Number of chimneys inspected by district chimney inspectors and found O.K.	1,268
Number of chimney repairs completed	3,508
Number of sanitary repair requests	2,904
Number of sanitary house inspections by city health board	1,114
Number of sanitary repairs completed	1,598
Total number of men registered: Reconstruction, 6,666; Cavicchi & Pegano, 1,200; Bate, McMahon & Co., 745	8,011
Total number of men working: Reconstruction, 2,973; Cavicchi & Pegano, 464; Bate, McMahon & Co., building temporary dwellings, 250; Eastern Investment Corporation, building temporary dwellings, 12; Falconer & McDonald, building temporary dwellings, 81; Dartmouth relief, 53; Fairview and Bedford relief, 17	3,850
Total number of teams working: Double, 33; single, 16	49
Total number of motor trucks	19
Total number of passenger cars	22

$20,000,000 Cash for Relief

The cash contributions to the Halifax Relief Commission total about $20,000,000, of which $5,000,000 (£1,000,000 sterling, to be exact) was voted by the British government, $12,000,000 by the Dominion government, and about $3,000,000 ($2,835,400 up to February 28th, 1918) by individuals, corporations, associations, municipalities, provincial governments and others.

The private and public donations of $50,000 or over were as follows: British Red Cross, $125,000; Bank of Nova Scotia, $100,000; Chicago Committee, $130,000; Mayor's Fund, London, Eng., $600,000; Province of Ontario, $100,000; Australia, $250,000; Province of British Columbia, $50,000; Dominion Iron & Steel Co., Limited, $50,000; Hero Land Bazaar, New York City, $75,000; Newfoundland, $50,000; Royal Bank of Canada, $50,000; St. John's, Newfoundland, $50,000; Greater Vancouver, $56,180; Winnipeg Free Press Fund, $85,011.

The amounts expended for rehabilitation and temporary relief, plus the amounts so required for the remainder of this year, total about $4,000,000, but this does not include permanent repairs to damaged property nor the restoration of buildings nor compensation for their destruction. An amount of $732,166 was expended by the various voluntary committees before the Relief Commission assumed control. This included transportation to or from Halifax given to 2,308 persons.

There are some special funds not administered by the Relief Commission, but none of these are of very large amounts excepting the $500,000 fund contributed by the people of Massachusetts for the specific purpose of refurnishing homes the contents of which were destroyed. This fund is governed by a Massachusetts committee working in co-operation with a Halifax sub-committee.

Amount of the Damage

The Relief Commission appraises the property damage as follows:—

Dwellings	$ 6,476,000
Contents	3,330,000
Schools	342,000
Public Institutions	222,000
Business Properties and Merchandise	1,041,000
Municipal and Public Buildings	105,000
Churches, Manufacturing Plants and Specials	3,484,000
Total	$15,000,000

These figures do not take into account the destruction of public property belonging to the Canadian Government Railways and the Naval Service Department of the Dominion Government, nor do they include the loss to shipping in the harbor of Halifax. The commissioners have been unable to obtain an accurate account of these losses, but they are of opinion that they may be safely estimated as not exceeding $10,000,000. The shipping losses will be substantially met by marine and war risk insurance, and the restoration of public property has been taken care of by the Dominion government. The extent of the whole loss (excluding any sums to provide for indemnification for loss of life or personal injury, or for trust funds for the education or support of victims or their dependents, or for loss of taxes to the city of Halifax) is placed at the sum of $25,000,000.

The above-mentioned damage to the property of the Canadian Government Railways is estimated as follows by the railway staff:—

Piers, Buildings, Tracks, Machinery, Power and Telegraph Lines, and Signals in Halifax	$ 751,600
Similar Structures in Dartmouth	52,700
Rolling Stock	178,000
Commissary Stores	17,700
Steamer	70,000
Miscellaneous Expenses in Cleaning up and Relief Work	155,000
Total	$ 1,225,000

Damage to Canadian Government Railways

The explosion occurred in the vicinity of Piers 6 and 8, where were located the principal sidings of the Canadian Government Railways. For a time it put the railway completely out of commission. Laymen who viewed the wreckage predicted that trains would not run into Halifax for a month, and even W. A. Duff, assistant chief engineer of the Canadian Government Railways, said it would take a week. However, Mr. Duff and C. A. Hayes, the general manager of the railway, and their staffs, set energetically to work; within two days they had cleared the main line and had trains running into the city.

The North Street station, which is the chief passenger terminal of Halifax, was practically in ruins, and the main tracks leading to the terminals for a distance of three miles had been blocked with debris. All telephone, telegraph and despatch lines were down, adding to the difficulties of operation.

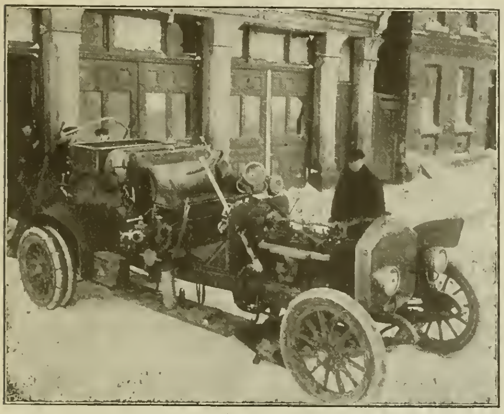
Fortunately the line from Rockingham to the new Ocean Terminals, and the terminals themselves, lay beyond the area of destruction, and although the rails had only been used for construction trains and the terminals were entirely without any proper means for the unloading or loading of freight, and lacked passenger accommodation, yet with such limited facilities as could be tem-

porarily improvised, it was possible to rush relief trains and supplies to the heart of the city and carry refugees therefrom. On the evening of the day following the disaster, the first regular train for Montreal also left from the new terminals and the latter were continued in use until the regular station was available.

Heavy cranes were put to work clearing away the wreckage, and by the second day after the disaster, trains were able to leave the regular passenger station at North Street.

Gangs of men were also put on the reconstruction work at Piers No. 2 and 3, North Street station, Willow Park and Richmond, and the work of repair was pushed to the utmost. Arrangements were made to erect additional freight sheds on the completed docks at the Ocean Terminals, to replace those lost at Richmond.

At the same time, order had to be restored in other branches of the railway service. The importance of the terminals called for a large and varied body of skilled



This Fire Department Auto was Travelling a Street Half a Mile from the Waterfront When the Explosion Occurred. The Driver was Blown Out of His Seat and the Machine Wrecked

labor. Hundreds of the employes had had their homes in the immediate vicinity of the catastrophe. They were naturally concerned about their families. The explosion had demoralized the local staff. Fifty-eight employees were killed, over forty seriously injured and over one thousand were incapacitated from their regular duties. Hundreds of employees were called upon from various parts of the line to fill the gap; a whole new staff had to be organized.

As soon as possible a survey was made of the railway properties. At Pier 9, the most northerly railway pier along the waterfront, the force of the explosion was such that the wooden shed had totally collapsed. Pier 8 was destroyed from the water level up, and Pier 6, the reconstruction of which had been completed just a few weeks previously, was completely blown away. No trace of it remained.

Richmond yard station, car repair buildings and cattle pens were blown to atoms; the water tank was rendered useless and the switchmen's shanties were so badly wrecked as to be unfit for repair.

The North Street passenger station sustained very heavy damage. A large portion of the train shed roof was blown up, the remainder practically collapsed and fell down inside the brick walls and what did remain was pulled down later on for safety. The glass was blown out of all the side windows and the doors blown out of their casings. In the solid brick station structure, all the doors, windows and fixtures were blown off, as also happened in the power plants adjoining the station.

On Pier 4 the shed was completely wrecked. Pier 3 had all the trusses on the north half of the shed broken and all the doors and windows blown out. Pier 2 had the doors all blown off on the north side, both upstairs and down. On the south side eight of the large steel doors were blown off and a number damaged.

The roof over the bins of the 500,000-bushel grain elevator was badly damaged.

Damage at Willow Park

At Willow Park, where engine cleaning and housing facilities are located, the doors and windows in the car shop, stores building, planing mill, oil house and engine house were blown out. The roof of the engine house was badly damaged and the greater portion of it collapsed. The power plant was put out of commission, and the power transmission line to North Street and Deepwater, which follows along the city streets, was also wrecked.

The telephone despatching line between North Street station and Rockingham was rendered useless by the explosion. All automatic signals between North Street station and Willow Park were badly wrecked.

With the early operation of the new terminals in view, temporary repairs were made on the old sites and North Street station was made habitable only temporarily.

Notwithstanding all this disorganization, eight days after the catastrophe all the branches of the service were working.

Special Railway Construction Organization

A special railway construction organization was made up to handle the work of repairing and rebuilding the railway structures, and the repairs to the naval dockyard were later also put into the hands of this organization, which consisted of a manager of construction, an architect and a naval man, assisted by two contracting superintendents who acted in a consulting capacity. Under this board there were assembled office and field engineers, draughtsman, auditors, purchasing agent, storekeeper, material men and commissary men. The office of manager of construction was held by C. B. Brown, assistant general manager of the Canadian Government Railways, and the execution of the work was under the direct charge of W. A. Duff, assistant chief engineer.

The Civic Reconstruction Situation

The railway organization normally included a large number of engineers and contractors; and on account of the Ocean Terminals work which was in progress, there was considerable construction equipment available. The city staff was in no such fortunate position, so on the morning of the disaster the emergency committee telegraphed to Ottawa to Col. Low, requesting his services. Col. Low's genius for rapid organization was well-known in Halifax and the committee decided that he was the man to handle the emergency. Col. Low consented to take charge of reconstruction for five or six months, but stipulated that his services and those of his staff be accepted without remuneration. He and his staff even insisted upon paying for their meals at the boarding camp, and it is understood from the Commission that Col. Low and Bate, McMahon & Co.'s staff did not get so much as a postage stamp from the Halifax relief work.

Shelter was the crying need of the hour after the explosion. The temperature dropped to 12 below zero and snow fell the night of the disaster and kept on falling most of the time until nearly April. It was the worst winter that Halifax had experienced in twenty years, and enormous efforts had to be made to house temporarily the afflicted thousands. Owing to the storms, even the work of merely repairing semi-shattered houses was difficult; but it progressed rapidly. Glass and glaziers poured into Halifax from every direction.

Eighty-four Temporary Apartment Houses

"We need food and glass, especially glass," Col. Low telegraphed broadcast. Chimneys were the next consideration, for fire-places and furnaces in thousands of houses could not be lit owing to damaged chimneys. Next, a type of temporary dwelling for the homeless had to be devised, and a city of frame and beaver-board structures sprang up at the rate of an apartment an hour. These dwellings were standardized in the form of two-story apartment houses, each house containing eight four-room-and-bath apartments.

Forty-four of these apartment houses were erected on South Commons by contractors, forty in the Exhibition Grounds by the commission, ten on Garrison Commons by Bate, McMahon & Co. (the firm doing this work free of charge), and eight in Dartmouth by the commission, a total of 102 houses, or 816 apartments.

In addition to the construction of the ten apartments and the two office buildings, and the services of Col. Low and his staff, the firm of Bate, McMahon & Co. also furnished the commission with about $25,000 worth of needed machinery for reconstruction plant. The firm had been asked by Chairman Rogers to help with the construction of the temporary buildings by assuming contracts, but they agreed to help only upon the understanding that their services would be accepted without remuneration.

Of the 44 apartments erected under contract, the Eastern Investment Corporation built twenty, and Falconer & MacDonald built twenty-four. The lump sum contract price was $6,600 per house, exclusive of water and sewerage works.

Early Resumption of Business

Speedy rehabilitation, so as to permit of early resumption of business, was the aim in determining what reconstruction should first be given attention. The principle of enabling the citizens to "carry on" again independently of charitable relief was the one adopted by the commission. The population of Halifax city and county at the time of the 1911 census was 74,662, and was estimated at over 80,000 at the time of the disaster; but more people than that number were affected, owing to the interruption to shipping. The exports from the port of Halifax for the year 1917 totalled $142,000,000; imports, $10,000,000. The customs receipts totalled $2,500,000; building permits, $900,000; value of manufactured products, $22,000,000; post-office receipts, $1,800,000; bank clearings, $152,000,000; civic assessment, $38,000,000; shipping, 17,100,000 tons; freight handled, 1,700,000 tons. The business that was interrupted by the explosion was, therefore, of no mean proportions, and the Relief Commission wanted the same sort of rapid construction work that had built Valcartier and Borden military camps in world's record time. It is true that there were some who preferred to assume the rôle of obstructionists rather than reconstructionists, but in the main the people bent to the task eagerly and helped Col. Low in every possible way to carry out the decisions of the Relief Commission.

Sanitary Precautions

The commission decided that a separate organization should be effected for clearing the devastated area, and awarded a contract to Cavicchi & Pegano, contractors, of Halifax, to carry out that part of the work. They were paid a lump sum price per load of debris carried away and also a certain sum for the remains of each body found, and the work was done very carefully so as to find every victim.

Dr. J. W. S. McCullough, head of the Ontario Provincial Board of Health, went to Halifax as consulting sanitary specialist, and upon his advice the devastated area was quickly and most thoroughly cleared of every particle of debris, to prevent unsanitary conditions arising, and possible epidemics, with the coming of warmer weather. Every drain was removed down to the sewer connections. The water mains and sewers were not injured, so far as could be ascertained upon inspection by the city engineer.

Town Planning Scheme

The devastated areas will be rebuilt under the direction of the commission. In this work a definite "town plan" will be followed. The scheme is being prepared by the town planning boards of the city and county under the advice of Thos. Adams, of the Commission of Conservation, who has been appointed consultant to both boards. In co-operation with the city engineering department, these boards are preparing draft schemes for five areas.

H. L. Seymour, D.L.S., of the surveyor-general's staff, Ottawa, has been loaned to the Commission of Conservation to assist with this work.

One scheme is being prepared for the city of Halifax for an area of about 3,285 acres and four schemes are being drafted for adjacent parts of the county of Halifax, comprising an aggregate area of about 20,000 acres. R. M. Hattie is secretary to the Town Planning Board. Public notice has been published under the Nova Scotia Town Planning Act of 1915, of the intention to proceed with this work under authority of the provincial commissioner of works and mines.

Greatest Explosion in History

At the official investigation into the cause and responsibility for the disaster, an American engineer in the employ of one of the largest manufacturers of explosives in the United States, and who had been selected by them to give expert testimony at the enquiry, said that the explosion at Halifax was the greatest that had ever occurred in the history of the world.

Explosives, he testified, are of two classes: (1) Gunpowder, the explosion of which is comparatively slow, as the material is a mechanical mixture and the flame has to spread from layer to layer. Such a material requires only flame to set it off, and its properties as an explosive are not improved by the action of a detonator, although that means of firing it can be employed. Gunpowder cannot be exploded by shock alone. (2) High explosives, such as T.N.T., picric acid, nitro-glycerine, and dynamite. These substances can be exploded by means of flame, but the best results are obtained by means of a detonator, such as a mercury fulminate blasting cap. This results in an instantaneous release of the explosive into a gaseous form. The gas expands at the rate of 7,600 metres a second, that is to say, about 8,300 yards, or over $4\frac{1}{2}$ miles a second. This applies to T.N.T. Ordinary blasting charges expand at the rate of three to four thousand yards a second. Of course, the effect of the explosion varies, picric acid or T.N.T. causing the

greatest results when detonated in a confined space, at high density.

The rapid expansion of this gas in all directions, declared the witness, drives the air away from the area over which the explosion extends. But the gases cool rapidly, and as they cool they again contract, creating a partial vacuum and allowing the air to rush in again over the affected area. It was this sudden withdrawal and return of the air over Halifax which caused houses to collapse like cardboard boxes and smashed the windows and doors of more substantial structures. The witness said that although it would be too light to be seen in daylight, the explosion would be accompanied by a flame which would spread over the whole area of the explosion, and he had no doubt that this flame was responsible for houses being set instantaneously on fire, although possibly in many cases fire would have occurred anyway from the upsetting of stoves.

The greatest previous explosion, said the expert, was that of 500,000 pounds of dynamite which blew up the steamer "Alum Chine" in Baltimore harbor. The "Black Tom" Island explosions of last year were caused by about 350,000 pounds of explosives similar to those which blew up at Halifax, distributed on freight cars and lighters. Even then, there were several different explosions. The island is about one and a half miles from the Battery, New York, where much damage was done, and glass was broken in some parts of Brooklyn, four miles away. There is no doubt, testified the witness, that the wreckage at Halifax was the worst ever created by any explosion in the history of the world.

ONTARIO'S METALLIFEROUS PRODUCTION

Returns received by the Ontario Bureau of Mines for the three months ended March 31st, 1918, are tabulated below. For purposes of comparison the quantities and values are given for the corresponding period in 1917:—

Summary of Metalliferous Production—First Quarter of 1918.

Product.	Quantity. 1917.	Quantity. 1918.	Value. 1917.	Value. 1918.
Gold (ounces)	127,692	113,387	$2,601,760	$2,265,521
Silver (ounces)	3,945,957	4,114,856	2,831,873	3,740,843
Cobalt (metallic) (lbs.)	84,710	37,545	78,668	75,625
Cobalt oxide (lbs.)	83,014	81,760	66,798	130,486
Nickel oxide (lbs.)	5,495	......	550	......
Nickel (metallic) (lbs.)	......	44,154	......	17,662
Other Cobalt & nickel compounds (lbs.)	118,292	143,381	13,695	18,386
*Nickel in matte (tons)	10,141	9,677	5,070,410	5,806,200
*Copper in matte (tons)	5,063	4,727	2,025,227	1,748,990
Copper ore (tons)	1,507	......	44,097	......
Iron ore (tons)	23,035	32,530	58,205	127,916
Pig iron (tons)	163,020	148,752	2,743,441	3,948,209
Molybdenite, concentrates (lbs.)	25,073	17,410	32,202	24,548
Lead, pig (lbs.)	263,046	60,283	27,290	5,066

*Copper in matte was valued at 20 cents and nickel at 25 cents per pound in 1917. For 1918 the values have been placed at 18¾ and 30 cents per pound, respectively.

Molybdenite ore, to the extent of 1,295 tons, was treated by the Mines Branch, Ottawa, and by the Renfrew Molybdenum Mines, Limited, at Mount St. Patrick. The output of the last-mentioned company is shipped direct to France. There are works at both Orillia and Belleville for the production of ferro-molybdenum.

MUNICIPAL ELECTRICAL ASSOCIATION

It was very fitting, said President E. V. Buchanan, of London, Ont., in opening the meeting of the Association of Municipal Electrical Engineers of Ontario in the Refectory in Queen Victoria Niagara Falls Park last Friday afternoon, that the first annual convention of the association should be held at Niagara Falls, where several million horse-power await harnessing.

About 160 engineers, representing municipal electrical plants throughout Ontario, three-quarters of which are Hydro plants, attended the convention, which lasted two days. The association was formed three months ago. A hundred and eighty-four municipalities were asked to join, said Secretary R. A. Clement, of Toronto, and eighty-three of these had already become members. There is a bank balance of over eight hundred dollars to the association's credit.

Just before the convention opened, the delegates watched a blast made for the Hydro's 13-ft. 6-in. pipe line which is nearing completion, and which will make possible the development of about 50,000 more horse-power at the Ontario Power plant.

The papers read at the convention were as follows:—

"Factory Lighting," by M. H. Madgsick, of the engineering department of the National Lamp Works of the General Electric Co., Cleveland, Ohio.

"The Evolution of Electrical Inspection in Ontario," by H. F. Strickland, chief electrical inspector, Hydro-Electric Power Commission of Ontario.

"Thirty Years as an Electrical Salesman," by Geo. Rough, vice-president, Packard Electric Co., St. Catharines.

"Overseas Trade," by Fred. W. Field, H.M. Trade Commissioner, Toronto.

"Application of Synchronous Motors to Industrial Uses," by M. J. McHenry, manager, Hydro-Electric System, Walkerville, Ont.

"Sales Service," by J. F. S. Madden, sales engineer, Hydro-Electric Power Commission, Toronto.

Wills MacLachlan, of Toronto, gave a valuable demonstration of a new and successful method of resuscitation.

H. G. Acres, hydraulic engineer of the Hydro-Electric Power Commission, gave a ten-minute talk on the Chippawa-Queenston development, after which the members were motored to the Whirlpool yards and from there were taken on a construction train to the power house site near Queenston; the machine shops, the sub-station and the big Bucyrus shovels being inspected en route.

The following officers were elected for the ensuing year: President, E. V. Buchanan, manager of the London Public Utilities Commission; vice-president, E. I. Sifton, Hydro manager at Hamilton; secretary, S. A. Clement, assistant engineer, municipal department, Hydro-Electric Power Commission; treasurer, R. C. McCollum, municipal auditor of the Hydro-Electric Power Commission.

The by-laws were amended to reimburse the members for their railway expenses in attending the convention; to add five district vice-presidents to the list of officers; and to admit non-voting and non-office-holding commercial members at a fee of $10 per annum. This class of membership will include manufacturers, contractors and dealers in electrical equipment and supplies dealing directly with the municipalities.

The Class A members are the municipalities, each of which can be represented at the meetings only by the chief operating executive of the municipality's utility.

IMPROVING ARCH ACTION IN ARCH DAMS*

By L. R. Jorgensen, M.Am.Soc.C.E.

THE fact that arch dams, and mainly those of heavy sectional area, do not develop arch action before considerable load has been applied to them, is generally known, but, to a great extent, has not been especially considered in their design.

At present, working stresses of about 25 tons per square foot, as used in ordinary dam practice, are sufficiently low to produce a safe structure, even in spite of the fact that the formulas used for the design do not consider everything.

It is obvious, however, that if the practical arch could be constructed in such a way as to coincide more nearly with the ideal arch—that is, one which acts as an arch from the very start, and in which the load is mainly

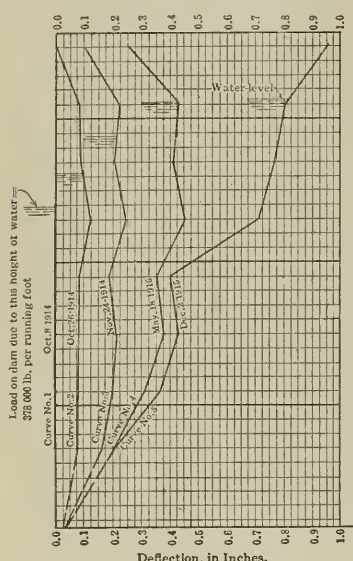


Fig. 1

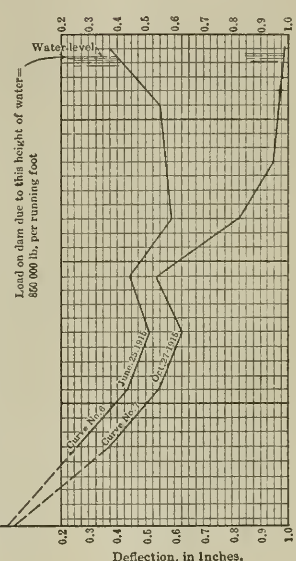


Fig. 2

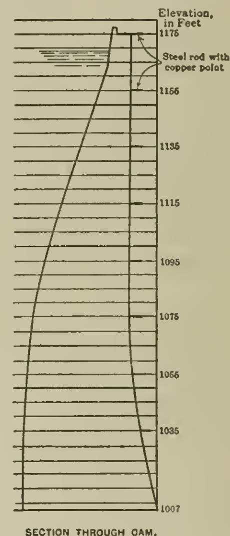


Fig. 3

carried by pure arch action—a still safer structure would result. Higher unit stresses than are now common could be used with safety, if arch action could be made more definite from the start. The factor of safety to be used would depend on the importance of the particular structure in each case.

The two main reasons for the phenomenon that an arch dam does not act as an arch before considerable load has been thrown on it are, as is well known: First, the shortening of the arch rib due to shrinkage; and, second, because the arch is fastened to the foundation.

The shortening of the arch rib is caused by the natural shrinkage of the concrete as it sets, the dissipation of the chemical heat, the permanent set after the reservoir has filled once, and the fact that dams are of necessity almost always built during the season of highest temperature.

This shortening of the arch rib is plainly visible on dams provided with contraction joints. With an empty reservoir, during cold weather, these joints will have opened up from ¼ in. to perhaps as much as ⅜ in., where spaced, say, 60 ft. apart. If not provided with contraction joints, a dam of heavy cross-sectional area will undoubtedly show cracks at more or less regular intervals from 40 to 80 ft. apart. A dam of slim cross-sectional area may not always crack, as it is somewhat flexible, and the crown can often be pulled in a down-stream direction without developing excessive tension in the arch.

In cases where the contraction joints have opened up, the water level in the reservoir will have to rise a certain distance in order to throw sufficient load on the structure to force the dam, acting as a cantilever, to deflect in a down-stream direction, before the voussoirs—that is, the bodies between the contraction joints—come into contact with one another. Only from that moment does the remainder of the water load divide up between the arch, the curved beam, and the cantilever.

In the case where the arch has not cracked, although under the influence of tensile stresses, the water level in the reservoir will have to rise until this tension has been compensated for by pressing back the cantilever. The remainder of the water load is then divided up between the arch, the curved beam, and the cantilever, according to their relative capacities for sustaining load.

The fact that the arch is fastened to the foundation prevents any considerable arch action from taking place at or near the latter; this, however, is not detrimental to the safety of the structure, such as would be the shortening of the arch due to shrinkage. The load on the lower portion of the arch causes shearing stresses in the concrete next to the rock and for some distance above and below. These shearing stresses, in turn, cause an elastic deformation, of both the dam and the rock foundation, to take place in a down-stream direction, especially at the crown of the arch, where the movement in that direction is the greatest. Ordinarily, the rock bottom has a higher modulus of elasticity than the concrete; it is well supported laterally from all sides, and therefore offers

*Abstract of paper presented before the American Society of Civil Engineers, June 5th, 1918.

greater resistance to this movement (perhaps three times) than the concrete, but there is nothing to warrant the assumption that the rock bottom is immovable, and measurements also seem to indicate that it is not although measurements of such movements are very difficult to make correctly, as they are so small in this region.

A trial calculation will ordinarily indicate very low unit shearing stresses at the foundation, even assuming that shear alone carried all the load on, say, the lower fifth of the dam.

The unit shearing stresses, in most cases (perhaps in all cases), will be less than the unit weight multiplied by the coefficient of friction; but, in any case, the weight of the structure will exert considerable unit compression perpendicular to the horizontal plane of shear, and thereby improve the ability of the concrete to withstand shearing stresses along horizontal planes.

Deflection Curves

The curves shown on Figs. 1 and 2 are typical for the deflection of the crown of an arch dam due to different water loads and different temperatures of the dam body.

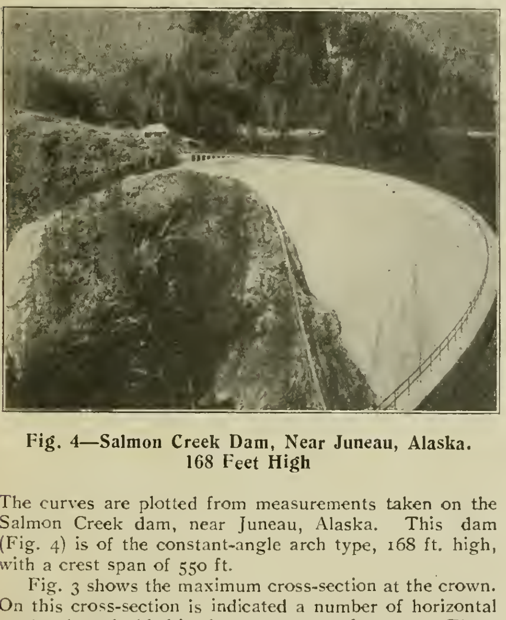


Fig. 4—Salmon Creek Dam, Near Juneau, Alaska. 168 Feet High

The curves are plotted from measurements taken on the Salmon Creek dam, near Juneau, Alaska. This dam (Fig. 4) is of the constant-angle arch type, 168 ft. high, with a crest span of 550 ft.

Fig. 3 shows the maximum cross-section at the crown. On this cross-section is indicated a number of horizontal steel rods embedded in the masonry, 20 ft. apart. These steel rods are provided with copper points on the downstream end for weather-proofing purposes. The different readings were obtained by sighting these points through a transit and determining their position in regard to fixed bench-marks.

It is very difficult to measure the deformation close to, or at, the foundation. It is so small that a transit reading would not be accurate enough, and if a stationary measuring apparatus was arranged on the ground, down stream from the dam, it would have to be at least 50 ft. distant in order to be on ground which does not take part in any movement caused by the load on the dam. The measuring tape or rod then becomes so long that all measurements taken must be compensated for temperature changes, and even a small error in such calculations or estimates will be sufficient to make this method of doubtful value. The best thing to do seems to be to extend downward, in a uniform direction, the curve obtained from observations at higher elevations.

The measurements on the Salmon Creek dam were commenced on October 8th, 1914, when the reservoir was filling for the first time, and the position of all the copper points on that date is taken as zero for all curves shown on Figs. 1 and 2. The actual zero will lie a little to the left; it may be some time before the water will be low enough to determine it by measurements.

The load due to the water level shown for Curve No. 1 was sufficient to keep the contraction joints (only two) closed.

Construction Features Cause Peculiarity

There is not much that need be explained about the results of the first and second deflection measurements—those taken on October 26th, and November 24th, 1914. The water kept rising, deflecting the crown in a downstream direction, about as might have been expected. The fourth measurement, Curve No. 4, taken on May 18th, 1915, begins to show some peculiarity about this dam, that is, the knee in the deflection curve at Elevation 1,095, which is still more apparent on the three following curves. This peculiarity is caused by construction features which must be known to be appreciated.

As it was necessary to stop construction work late in the fall of 1913 at about this elevation, the zone of the dam in this vicinity was built during the coldest portion of the fall and the coldest portion of the following spring. The total shrinkage of the concrete in this zone, therefore, has been less than the average, and the arch, therefore, takes a greater proportion of the total load than it does either above or below; in fact, some load is transferred through the vertical beam (the cantilever) to this zone from both above and below. Such transference of load also takes place through the vertical beam at the crest, as shown by Curve No. 4, but this would be expected in any case.

Curve No. 5 shows considerably more excess deformation of the dam than Curve No. 4, although the water load is only slightly higher, but Curve No. 5 was plotted from measurements taken on December 2nd, 1915, at a time when the days had been short and cold for some time, compared with the long, warm days around May 18th (Curve No. 4). Curve No. 5 also indicates that the outside temperature has been lower than that of the water and the dam body below the water level for some time, as the portion of the dam above the water level is forced downstream to a greater extent than the lower loaded portion as a result of the greater shortening of the arch (rib) in the upper region, produced by a lower temperature in the upper exposed portion of the dam.

Deformation Due to Temperature Changes

Curves Nos. 6 and 7 give an idea of the magnitude of the deformation due to temperature changes alone. The water load is the same in both cases—that due to reservoir full—but the average temperature of the dam body was high when the measurements for Curve No. 6 were taken, on June 25th, 1915, and low when the measurements for Curve No. 7 were taken, on October 27th, 1917. The days, of course, are still shorter and colder in January (Juneau, Alaska) than in the latter part of October, but October 27th was the last day the reservoir was full to the spillway crest.

Both curves are of the shape expected, except for the knee at Elevation 1,095, but low temperatures at the time of construction were responsible for that, as already explained.

That the upper end of Curve No. 6 turns in an up-stream direction, the same as on Curves Nos. 2, 3 and 4, is only logical. All dams—and this is no exception—are provided with an excess of material at the crest, and therefore the stresses and the resulting deformation must be less in this than in lower zones; besides, for Curves Nos. 4 and 6, the outside temperature, and therefore, also, the temperature of the dam body, especially at the crest, was higher than that of the water on May 18th and on June 25th.

This higher temperature of the crest portion tends to accentuate the pointing of the upper portion of Curves Nos. 4 and 6 in an up-stream direction. Curve No. 7 (October 27th, 1915) indicates the effect of lower temperatures of the crest portion, than that of the water and of lower portions of the dam body.

The horizontal scale of these curves is exaggerated 1,200 times, in order to show the results more plainly. In reality, the curves are smooth, although the irregularities, as shown, are present.

In the foregoing description, some of the actions and behaviors of arch dams have been explained in detail. In the following the method of eliminating some of the undesirable features and making the structure act more like a theoretical arch, than otherwise possible, will be outlined.

By a simple system of iron pipes (shown in Figs. 5 to 8), distributed on the face of the contraction joints, and provided with slots at certain intervals, it is possible to deliver cement grout under pressure into the space (from ¼ to ⅜ in. wide) between adjacent walls of the contraction joints, and put initial axial compression into the whole structure, thereby making it act like a solid arch.

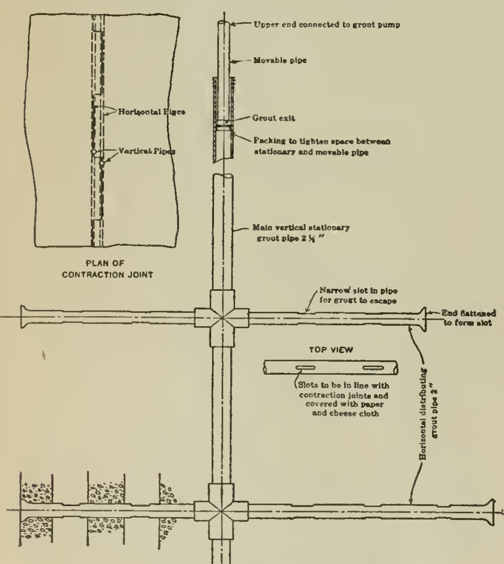


Fig. 5—Arrangement of Pipes for Grouting

At the same time, this grouting will greatly improve the watertightness of the dam.

It is well known that contraction joints, even of the most efficient design, cannot be expected to be entirely watertight. The leakage through such joints on large structures may easily amount to from 10,000 to 20,000 gallons daily, and has amounted to as much as 450,000 gallons daily. This can be eliminated by grouting the joints under pressure; still, the main purpose of this grouting is to compel the arch dam to act as an arch from the very moment the water begins to fill the reservoir.

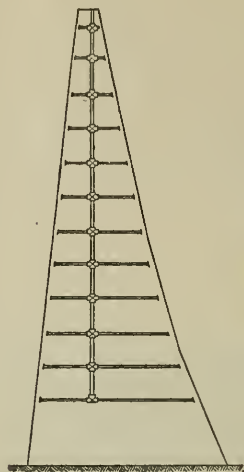


Fig. 6

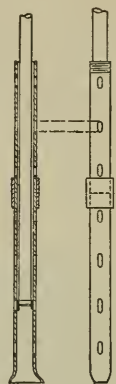


Fig. 7

Fig. 8

Forcing the grout into the contraction joints, and keeping it there under pressure until it has set, presses the crown of the arch in an up-stream direction, and puts shear on the foundation in the opposite direction to that due to the water load. It seems logical, therefore, to use such a grout pressure as will force the crown up stream half the total amount of the deflection resulting from a full reservoir. In this way the maximum shearing stresses are reduced by one-half (reservoir full), the maximum cantilever stresses are reduced by one-half, and, when fully loaded, the arch compression should then be as nearly as possible in accordance with the values obtained from the simple formula:

$$\text{Unit compression} = \frac{\text{Unit water pressure} \times \text{upstream radius}}{\text{Thickness of section}}$$

A check on the necessary grout pressure can be obtained by sighting across the crown of the arch with a transit, after first establishing the necessary bench-marks.

Great refinement in choice of final grout pressure, however, cannot be counted on, and is not essential. Considering the great influence of the temperature on the total deflection of the arch structure, as can be seen from the curves, especially Curves Nos. 6 and 7, it is necessary to use some judgment as to what the grout pressure should be in each case.

As a general rule, it can be stated that the grouting ought to be accomplished at a time when the structure is cold, and when the joints, therefore, have opened to their maximum extent, permitting easy access for the flow of all parts of thin grout (1 cement to 7 water to start with and thicker to finish). A large dam will generally have the least volume during March, and, therefore, the contraction joints will have opened up a maximum during this time, if the reservoir is empty.

When applying the grout pressure at such a time, it should be kept in mind that the dam body is larger at any other time, due to an increase in temperature, and that, with the cracks closed, the compression per square inch

of contact surface will be increased as the temperature of the dam body increases.

Thus far only arch dams have been mentioned, but it would not require much explanation to show the advantage of tight grouted contraction joints on straight gravity dams also.

Grouting the contraction joints under pressure on straight dams throws longitudinal compression on the structure, and enables it to act as a beam held at both ends, at least until the initial compression has been overcome by the beam tension. A trial calculation will prove that the factor of safety has been greatly improved, especially at the lower levels, unless the dam is very long.

Grouting Worth Its Cost

The grouting of the joints naturally improves the watertightness of the dam, and, for this benefit alone, it is worth its cost. Judging from the results of analysis of leakage water through concrete dams, there are good reasons for assuming that a tight dam is going to remain safe for a longer time than a leaky one, although the writer is not attempting to predict the probable natural life of any dam.

A straight dam which has its contraction joints grouted under pressure during the cold season, will automatically have this pressure increased during the warm season, at the site of about 11 lbs. per square inch for each degree of rise of temperature of the concrete of 1° Fahr., as this material tries to expand and cannot. This, of course, should be allowed for, when selecting the grouting pressure for a straight dam. There could be no objection, however, to having a longitudinal compression of, say, from 200 to 300 lbs. per square inch, or even more, on the concrete during the warm season.

A typical grout piping arrangement for a rather large dam section is shown by Figs. 5 and 6.

Feed Pipes Remain in Dam

On the plan of the contraction joint on Fig. 5 there are two vertical feed pipes which are desirable on a joint of the kind shown. Each vertical pipe feeds a system of horizontal pipes arranged at different levels. These horizontal pipes are provided with slots wherever they cross the open space of a joint (Fig. 5). When the pipes are put in place, these slots are covered with paper and cheesecloth to prevent the concrete from entering the pipes from the outside and blocking them. Later, when the contraction joints open, this covering will either adhere to the concrete, or the grout pressure will burst it open.

The pipes cannot be recovered, but will remain forever buried in the dam. They are necessary, however, in order to keep the grout in a liquid condition from the time it leaves the pump until it passes through a slot very close to the desired point of deposit. The iron walls of the pipes do not absorb any of the water in the grout; the absorption, however, commences as soon as the grout leaves the exit slot in the pipe and comes in contact with the concrete walls of the joint. Therefore, his outside grout sets first and shrinks, to a large extent. The grout in the pipe system, being fluid for a long time, is able to follow up the shrinkage and fill out the cavities and keep the joint under pressure until the filler has solidified, in from ½ to 1 hour or more.

Avoiding Air Pockets

To avoid air pockets as much as possible, and otherwise to insure uniform work, the grouting should proceed from the bottom up; therefore a second, and movable, pipe is inserted in the stationary vertical pipe at the time grouting is to be done, as indicated in Fig. 5.

When starting to grout, one end of this movable pipe is to be at the bottom of the vertical pipe, the upper end being connected to the grout pump by a flexible connection. Grout is forced through the movable pipe and flows through the lower Tee, the lower horizontal pipes, and the slots in them; out into the space between the walls of the contraction joints, and rises vertically.

Before grouting commences the down-stream end of the contraction joints should be caulked (with lead wool) except for small stretches left open for exploration purposes. These are closed when the grout starts to flow out of them. The up-stream end of the contraction joints are generally provided with copper plates or other kinds of effective stops.

When the grout has reached the second story of horizontal pipes, or nearly to it, the movable pipe is raised so that the lower end is just above the Tee connection leading to those pipes. Grout is then forced into them, and, proceeding in the same manner as previously described, the crest is eventually reached. Then, finally, the pressure is kept on until the filler has thoroughly set. It is the grout pressure used on the last, or preferably on the last two joints, spaced one-third of the arch length apart, that determines the initial arch compression, and therefore on these the greatest care should be exercised.

Grouting During Cold Weather

If a dam is so large and high that it takes two or three seasons to build it, it is advisable to grout the lower third of the height at the end of the cold season, before the construction of the dam is continued; otherwise, the lateral expansion (Poisson's ratio), due to the weight of material on top, will tend to close the contraction joints. These spaces will always be narrower close to the foundation than higher up, due to shearing stresses, developed by shrinkage in the concrete close to the rock bottom, tending to prevent complete contraction.

When grouted during cold weather, an arch dam will always be under the influence of compressive stresses, and any knee in the deflection curve, due to inequalities in temperature during the construction period, will be flattened out. All told, the arch dam will act more nearly as intended, carry the load as calculated, and be more water-tight than without the grouting of the contraction joints. A straight dam will have its factor of safety increased, due to the positive beam action, and also be more water-tight.

Figs. 7 and 8 illustrate a simple arrangement of grout piping for the contraction joints of a small dam.

The public utilities of the city of Edmonton are all on a satisfactory basis, with the exception of the street railway system, and new rates have been adopted with a view to wiping out the deficit on this account. The statement of revenue and expenditure of the different departments for the month of March, 1918, shows a net surplus of $5,403 for all utilities. The surplus for the first three months of this year is $37,543, compared with $20,122 for the corresponding period in 1917.

A company, known as the Beaver Cove Lumber Company, Limited, has commenced the construction of a large pulp and lumber mill at Beaver Cove, B.C., 165 miles north of Vancouver. It is understood about $3,000,000 or $4,000,000 will be invested, and the daily capacity of the plant will be 40 tons of pulp and 100,000 feet of lumber. The company has timber resources totalling five billion feet, and the cost has been over $2,000,000. The property includes some fine spruce, which it is the intention to cut as soon as possible for use in aeroplane construction.

SUPERELEVATION OF HIGHWAY CURVES*

By J. W. Lowell

MANY people look upon superelevation as a convenience to automobile traffic and especially the speed fan. Some take into consideration the factor of safety, but few have given serious thought to the question of maintenance which is equally important.

Any observing person who uses the road knows that curves are generally in worse condition than the straight road. This condition appeared simultaneously with the motor vehicle and has likewise grown with it. One need only to be in an automobile and feel the thrust against the side of the car when rounding a curve to appreciate why pavements ravel, rut and wear out fast. It is hard to realize the severity of the thrust given to the pavement surface and to the wheels and tires of a car when rounding a curve, but we know it is sometimes great enough to cause heavy cars to tip completely over. A curve on a road race-course just after a race is a good example of accelerated disintegration of roads on curves.

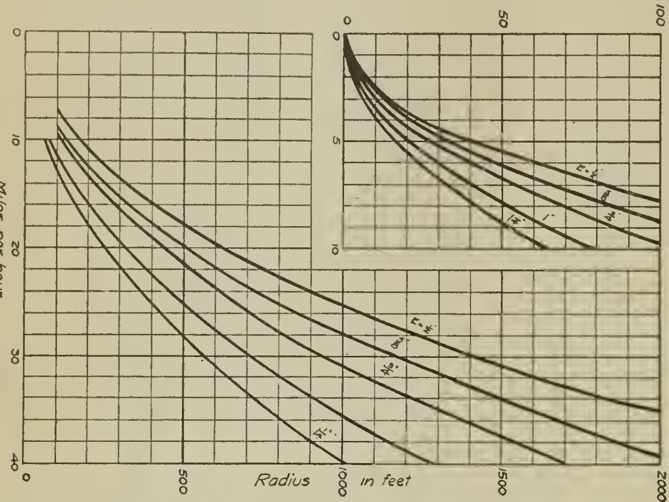


Fig. 1—Curves for Superelevation of 1 in. to 1½ ins. Per Foot for Speeds Up to 40 Miles Per Hour

Safety to traffic is a problem which must be given serious consideration, for fatalities are increasing at an enormous rate. Superelevating curves will not be a panacea for all road troubles, but it should lessen the fatalities on curves, which is one of the places where many occur. The strain on automobile wheels sometimes breaks them, causing serious accident. This can be eliminated by superelevation which does away with thrust. Superelevation makes both road tracks alike and there remains no object to cross over to the wrong side. With the crowned road there is a tendency for drivers to take the inside of the curve to avail themselves of the superelevation formed by the crown.

Superelevation will result in convenience for all motor traffic which constitutes the majority of vehicles. Both driving and riding will be safer, smoother, more economical and more comfortable.

However, roads are built to accommodate all kinds of traffic and therefore must be designed for the horse as well as the motor. These represent the extremes in speed and stability of footing.

If we superelevate for motors at high speed the horse cannot keep his footing, therefore the maximum superelevation attained should not exceed ¾ in. per foot of width for hard surfaced roads such as concrete and brick and 1¼ ins. per foot of width for stone, gravel or dirt roads. With these slopes horses should pull comfortably, for they are not greater than the ordinary crown.

Just to what extent this small amount of superelevation will be of value is illustrated by Fig. 1, showing the speeds that may be attained on various sized curves for these small superelevations. Analyzing the curves with the thought in mind that the sharpness of curve controls the speed, it is evident that the permissible superelevation compensates for speeds that are likely to occur on most curves from the sharpest to the flattest. Should the speed be excessive and not entirely compensated, we have at least by our superelevation minimized its effect.

Naturally the smoothness and wearing quality of road surface influence the effectiveness of superelevation to a small extent where only part compensation is attained, but after all, we have this condition on roads as now built.

There are probably many ideas as how best to construct a superelevated curve. The problem can be made just as complex as the designer desires. The simplest method is to construct the entire curve at full elevation by raising the outer edge, keeping the inner one to grade and changing from crown the superelevation in a distance of about 30 ft. on the straight road.

*"Concrete Highway Magazine."

NEW INCORPORATIONS

Sandon, B.C.—Silversmith Mines, Ltd., $750,000.

Victoria, B.C.—National Motor Co., Ltd., $10,000.

Kamloops, B.C.—Mountain Sawmills, Ltd., $50,000.

Quebec, Que.—Mile End Milling Co., Ltd., $200,000; E. Turgeon, E. Turgeon.

Toronto, Ont.—Hill Gold Mining Co., Ltd., $3,000,000; W. Gilchrist, J. Stewart, H. J. Stewart.

Stratford, Ont.—McDermid and Kyle, Ltd., $40,000; T. J. Kyle, M. A. McDermid, E. McDermid.

Longueil, Que.—Standard Foundry, Limited, $90,000. Emile Colas, Jules Colas, Miss Emelie Colas.

Three Rivers, Que.—Bellefeuille & Trepanier, Limitée, $49,500. Auguste Bellefeuille, Bruno J. Trepanier.

Admaston, Ont.—North Bonnechere Telephone Association, Ltd., $100,000; J. Barr, J. Payne, R. B. Leich.

Plessisville, Que.—Gregoire Lumber Corporation, Limited, $45,000. M. M. Napoleon Gregoire, J. L. Gosselin.

Montreal, Que.—Union Engine Machine Works, Ltd., $150,000. Griffith Lloyd Williams, Janet Burge, Peter Joseph Kenny.

The Pas, Man.—Herb Lake Gold Mines, Limited. $1,000,000. Clive J. McLeod, Melrose S. Everall, Harley M. Hughes.

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Principal Contents of this Issue

HALIFAX

DESPITE the terrible effects of the "Mont Blanc" explosion, or perhaps partly as a result of it, Halifax is to-day one of the most prosperous cities in Canada. Halifax has recovered courageously and splendidly from the effects of the explosion, and when the devastated area has been rebuilt according to a modern town-plan, Halifax will rise great and glorious from the ashes.

Assuming that the government will give Halifax its due, nothing can prevent that port from becoming one of the most famous in the world. It has all the natural advantages, physical and geographical, for ultimately becoming one of the busiest, if not the busiest, on the American continent.

The recent announcement by the Minister of Marine and Fisheries that the government has awarded contracts enabling the location of a shipbuilding industry at Halifax, is fine news. Halifax needs shipbuilding very much indeed. Without a big shipbuilding plant, the port could never attain its proper place in the world's shipping trade.

The taking over by the government of the Halifax Graving Dock Company's property is also a step in the right direction. A larger dock is needed at Halifax, but competition between the old privately owned dock and a new government dock would be unfortunate. The acquisition of the private dock enables the co-ordination of all terminal facilities at Halifax. The dock was practically public property anyway, being adjacent to the naval dockyard and being devoted, at the present time at least, largely to the repair of vessels directly associated with war work.

The Federal Government's $30,000,000 scheme for the development of Halifax harbor, which was announced some years ago, is still mostly on paper. A relatively small portion of the quay wall has been finished, some temporary sheds have been erected and a contract was recently awarded for a temporary station and car repair facilities; but a photograph of the Halifax terminals at present would not much resemble the architect's drawing of the finished project. It is to be hoped that the Dominion Government will go ahead with the development of this harbor as vigorously as possible. Financing of war needs, of course, must have the first consideration; but it is to be hoped that some way will be found of getting Halifax harbor into such shape that it will not be hopelessly behind in the race for trade after the war.

Notwithstanding the activity of Hun submarines, the tonnage of the principal American and Canadian ports has greatly increased since the war began. In 1913 the tonnage of the port of New York amounted to 28,000,000 tons, whereas for 1917 it rose to 34,000,000; and on account of the value of the shipments it became the leading port of commerce of the world, its exports last year totalling $1,964,000,000, whereas London, which had for years held the foremost place, dropped from $2,004,600,000 in 1913 to $1,867,000,000 in 1917.

This tendency toward increases in the American trade has extended to Canada on a smaller scale. The returns for 1917 make Halifax the third port on the American continent, on the Atlantic coast. In 1913 the Halifax tonnage amounted to 3,182,923 tons; in 1917 it totalled 17,092,911 tons, although part of this was "examination" tonnage. The figures for the year 1918 have greatly exceeded the 1917 figures for the corresponding months, some months showing an increase of over 100 per cent. as compared with the corresponding periods of last year.

Many Canadians do not realize the importance of the port of Halifax. Arguments are brought forth such as the "long rail haul," whereas the same export freight rate exists through all the North Atlantic ports. While there is a published differential of one cent against the port of Halifax, this is practically on paper only. The steamship, as a rule, absorbs it.

In 1913 Halifax bank clearings totalled $105,347,626, whereas in 1917 they had increased to $151,812,752. The figures for 1918 show continued increase.

The set-back which was suffered by the port of Halifax as a result of the explosion on December 6th, 1917, was of a very temporary nature so far as the commercial welfare of the city was concerned.

CONSERVATION AT NIAGARA FALLS

TRUE conservation is being practised at Niagara Falls in the Chippawa-Queenston Power Development. With the tremendous energy shortage in Ontario—neither fuel nor electrical energy being available in sufficient quantities—it would be extremely wasteful not to utilize every second-foot of the 36,000 c.f.s. allotted to Canada as permissible diversion from Niagara Falls, under the treaty between Great Britain and the United States. And so far as possible it should all be used in high head development. Were the whole 36,000 c.f.s. passed through the Queenston power house, it would yield over a million horse-power, compared with less than half that figure if used under existing conditions. Ontario cannot afford to waste that extra half million horse-power. Nor can the United States afford to lose the extra 100 ft. head that the Queenston scheme affords compared with the best conditions now available on that side of the line. The world war has brought Canada

and the United States together in closer fashion than many seem to realize. The bond between the two countries is inseparable. Why not merge their interests at Niagara and ultimately develop their whole 56,000 c.f.s.—or as much of it as can be diverted from the rapids without causing danger from ice jams—in one big, efficiently-operated, international plant at Queenston, dividing the resulting power in the ratio of 20 to 36, and sharing the total cost in inverse proportion?

PERSONALS

Col. Robert Smith Low, manager of reconstruction at Halifax, was born October 16th, 1874, in East Saginaw, Michigan. His parents were Scotch, and they returned home when "Bob" was an infant. In 1886 the family moved to Halifax, where the son commenced his career as a timekeeper in his father's business, later becoming assistant superintendent. In 1895 he went to the United States and stayed for two years, returning to become superintendent of his father's company. In 1899 he decided to go into business on his own account, and formed a partnership as McManus, Low & McManus, general contractors, in Sydney, N.S. The firm name was changed the following year to Low, McManus & Horne, and again in 1901 to R. S. Low Contracting Co., under which name Col. Low operated until 1912, when he joined the firm of Bate, McMahon & Co., contractors, Ottawa, as partner and manager. He is also a director of several other concerns. At the outbreak of war he was called upon by the Minister of Militia to build Valcartier Camp and completed the work with exceeding rapidity. The record he established there caused both the Militia Department and the Imperial Munitions Board to entrust to him the building of all their camps, eleven in number. At Camp Borden he undoubtedly established a world's record for work of that character. Among the contracts on which he has been engaged are: Dominion Iron & Steel Co., foundations and plant; Intercolonial R'y terminals at Sydney, N.S.; Marconi Station, Table Head, Glace Bay, N.S.; government roads and paving in Maritime Provinces, 1902-1910; paving in Ottawa, 1911; Bate, McMahon & Co., on a wide variety of contracts, since 1912. In August, 1914, he was made an honorary colonel and on February 1st, 1916, was gazetted as Lieutenant-Colonel engaged in military construction work. He has carried out over a million dollars worth of construction work free of charge for the government since war began, including the Halifax fortifications, and has completed several millions more upon a percentage basis. His services at Halifax were offered to the city without remuneration. It may be mentioned that Colonel Low has received no salary or allowance of any kind since undertaking charge of the reconstruction work in Halifax, either before or since the appointment of the Relief Commission. Just recently Col. Low signed two large contracts for his firm, one for the construction of a big plant for the British America Nickel Co., which he agreed to complete in a very few months, and the other for the erection of the new Federal Office Building at Ottawa, a $1,000,960 job.

British and Colonial Press Photo.

E. W. Pattison, of New Westminster, has been appointed municipal engineer of Langley, B.C.

Major Geo. W. Shearer has been awarded the D.S.O. Before joining the forces Major Shearer was an electrical engineer. He is a graduate of McGill University.

J. A. Burnett, electrical engineer, Grand Trunk Railway, has been appointed as technical assistant to the British War Mission at Washington, D.C.

Lieut. Wilmot J. Baird, who has been awarded the Military Cross, took his B.A.Sc. degree at the University of Toronto in 1911, and enlisted in the 1st contingent.

C. R. Polairet, of the Department of Commerce and Industries, of India, last week inspected the hydro-electric plants at Niagara Falls. Mr. Polairet is en route to Great Britain.

Frank C. Christie, an honor graduate in civil engineering at the University of Toronto, has gone overseas with the Royal Engineers and intends to train for a commission in England.

John Perrie, deputy minister of municipal affairs for Alberta, is taking an extended holiday owing to ill-health. J. H. Lamb will be acting deputy minister during Mr. Perrie's absence.

Lawford Grant, general manager of the Eugene F. Phillips Electrical Works, Limited, has been elected a member of the executive council of the Montreal Branch of the Canadian Manufacturers' Association.

Lieut. Lawrence B. Tillson, of Bracebridge, Ont., a graduate in Applied Science and Engineering, class of 1915, University of Toronto, has returned to Canada on leave. Last September Lieut. Tillson was awarded the Military Cross while serving in France.

Lieut. J. W. B. Blackman, who resigned as city engineer of New Westminster, B.C., to go overseas with a railway construction company, is now in France. He was loaned sometime ago to the construction department of the British War Office for the purpose of constructing an aviation camp in England, but he recently completed that work.

OBITUARY

Wilford Phillips, for seventeen years manager of the Winnipeg Street Railway, died last week. In March, 1890, Mr. Phillips accepted a position with the Metropolitan Railway Co., of North Toronto, and remained there until July, 1892, when he accepted the position of engineer and superintendent of North Toronto Waterworks and Electric Light Company. In March, 1893, he became engineer of the Niagara Falls Park and River Railway, and in 1896 was appointed manager of the same company. In June, 1900, he resigned, and in August, 1900, he accepted the position of manager of the Winnipeg Electric Railway Company, which position he occupied until just a few months ago.

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Are Sewers Remunerative to Small Municipalities?

Analysis of the Costs and the Benefits—It Pays to Construct Sewerage Systems Even in Very Small Towns, Claims Paper Read at the Hamilton Convention of Medical Officers of Health

By FRED. ALFRED DALLYN, C.E.
Ontario Provincial Sanitary Engineer

SMALL towns in Ontario are, almost without exception, provided with waterworks systems, originally designed for fire protection, but to-day, through progressive development, available as water supplies and, indeed, generally used as such.

The characteristic persistence of rural tradition in the small towns of Ontario has, however, retarded the complete acceptance of this new convenience, and according to available figures, only from 80 to 90 per cent. of the population are connected to such systems. Wells continue to be used by the remainder, some wells persisting even in very congested districts; especially is this true if the water supply of the town is subject to suspicion. Local officers of health are, however, rapidly dealing with the situation and are effecting improvements through two measures, in both of which they have the full co-operation of the Provincial Board of Health. The first is the protection of municipal water supplies and their purification, borne if necessary by general rates. Second, the abolishing and closure of all wells within the area where urban conditions may be said to exist.

These measures, when properly carried out, invariably put the waterworks on a paying basis, eradicate waterborne disease and introduce relatively large amounts of water into the home which must later be disposed of. It is to the disposal of wastes that this paper directs attention.

The Way to Avoid Complaints

It is not within the province of this paper to dwell at length on the various methods available for the disposal of wastes, or to describe minutely the odors and stenches occasioned by the improper discharge of slops and filth from sanitary conveniences. Neither is it necessary to remind this audience of the complaints so commonly arising from the pollution of wells by cesspools and septic tank systems; complaints, by the way, only too frequently founded on fact. Nor is it required to touch the troublesome conscience that wakes up every time a medical officer of health gives countenance to the use of some artifice which, whilst removing some local nuisance, directly contravenes the Public Health Act which he has been appointed to uphold. It is enough for me to state that the proper way of protecting a town and of avoiding many causes of complaint is to induce the municipality to adopt a sewerage system.

This step is recommended, not solely for the sanitary improvement bound to accompany it, but in addition, for the economic advantages which are as truly evidenced in the inducement it offers to manufacturers to locate in such towns, as well as the actual saving in cost and ease of payment compared with other methods of sewage disposal.

The greatest obstacles to the improved sanitation of the small town are its rural tradition and the opposition of wealthy and established citizens whose tax rates are liable, from the peculiar nature of their holdings, to be disproportionately affected by local improvement rates.

Obstacles Fast Disappearing

The first of these obstacles is very fast disappearing, owing largely to the splendid organizing ability of our women. We have to thank also the excellence of the propaganda work of the extension services of the agricultural colleges and the women's institutes, and in no little measure the everlasting effort of the local medical officer of health.

The second obstacle is more difficult to handle, but can readily be counterbalanced by publicity, and as a final resort the mandatory powers of the provincial Board of Health may be evolved. My own experience is that almost invariably when a systematic effort is made to ensure the passing of a public health measure involving a money vote, the citizens respond with substantial majorities.

There is one other obstacle which is worth mentioning. I have reference to old property held in downtown districts for which the taxes far exceed the rental values. To properly appreciate the difficulties of effecting improvement of such property, one must look to the experience of the larger cities. There one meets but one answer, "coercion." In order to meet the distress that arises in some instances through requiring the installation of sanitary conveniences, the Public Health Act provides that a local board of health in any city may direct that the cost, including interest at 6 per cent. on the deferred payments, be paid by the owner in equal successive annual payments extending over a period not exceeding five years, and that such annual payments be added by the clerk of the municipality to the collecters' rolls and collected in like manner as municipal taxes. The installation in such cases is directed by the city.

Engineers to-day should not attempt to lay out new towns for industrial purposes without providing sewers and water mains. This is true also in the temporary military encampments. The more obvious reasons are:—

The skilled and essential portion of the industrial class is accustomed to city dwelling and both expects and demands the convenience of a water supply in the house.

Town sites which are not sewered or drained present, during the spring, intolerable conditions.

Engineers as a class think logically and appreciate the difficulties connected with and the complaints apt to arise from local disposal of water in congested areas, and from the nature of the problem can recognize the economic advantages of a general system,—advantages mainly of a town-planning nature; that is, advantages not capable of full realization to-day but which appear more markedly as the town grows and congestion increases.

Substantial Return in Health Insurance

The most potent appeal, however, comes from the fact that investments promoting improved sanitation offer a substantial return in health insurance. This, of course, is not so apparent in towns hitherto blessed in having a general absence of disease, but is most assuredly so in all communities in which avenues for the approach of disease, hitherto wide open, are forever closed.

Of all classes benefiting by the sanitary improvement brought about by the extension of water and sewerage systems, the poorer industrial class benefit the most; and of all age groups showing improvement in mortality statistics, the group under one year, or our infant death rate, shows the greatest.

The connection between the living conditions of the laboring, or industrial classes and infant mortality is very great. Those of you who have been following the infant mortality statistics of recently published reports in the United States must have been struck with the fact that the highest infant mortality was invariably associated with the lowest incomes. Unfortunately, in our industrial towns, housing is expensive and the families with small incomes must accept very inferior accommodation. Frequently they must inhabit property which the landlord will not improve except when coerced.

The medical officer of health who is remiss in his duty and does not pursue such landlords and insist on destruction or improvement, must accept full responsibility for a portion of our infant mortality; often (so far as can be gathered from the meagre statistics as yet available) not less than three per cent. of the total births in the communities which he serves. So far as the workmen's cost of living is concerned, the increased rent chargeable to the installation of sanitary conveniences, and a connection to the sewer, never need exceed $17 per annum, $3 of which is for local improvements, $2 for sewage disposal, and the interest on $200 at 6 per cent., or $12 per annum. In terms of monthly rent this equals $1.45; or at an average figure, an increase from $15 per month to $16.50.

Seventy-Seven Cents Per Capita

The other economic aspects of the question are fairly summed up in a statement appearing in the financial statistics of the United States Bureau, to the effect that the combined annual cost of sewerage and waterworks operation in American cities of between 20,000 and 30,000 population was $3.65 per capita, and in a further statement in a report of the consulting sanitary engineer of the International Joint Commission, to the effect that for border towns an average annual per capita charge of 77 cents represents the cost of constructing interceptors and sewage treatment satisfactory for the protection of the purity of the boundary waters.

Available figures in Ontario are not greatly different, and it can be shown that $16.20 represents the per capita cost of installing a sewerage system in the average town. Interest and sinking fund retirements amount to $1.40 per capita per annum, to which must be added a small maintenance charge (at an outside estimate I would say $1), totalling $2.40 per capita per annum.

Should Study Town Planning

Both the Canadian Public Health Congress and the Medical Officer of Health Association might derive great profit from closer studies of town-planning movements. A little over a year ago I had the privilege of inspecting a great deal of the new housing and town planning work in England and Scotland. Unless we in this country exercise greater care than we are doing to-day, we are going to perpetrate conditions akin to those from which they are endeavoring so hard to escape. The fault lies not with our legislature, which has shown itself only too ready to advance municipal betterment, but in ourselves, —in our calm indifference to social wrongs, the growth of which to-day might well promote a stench in our nostrils.

Private philanthropy has at no time solved the housing problem, and in England even in those industrial centres where the greatest amount of money has been spent, such as at Port Sunlight by Messrs. Lever Brothers, the working class housed in the model village is less than 30 per cent. of the total persons employed. Industrial expansion, whether it takes place with high wages or with low, has in the past shown itself alike indifferent to the housing of the working man. The laborer cannot afford to pay the exorbitant profits on housing such as is asked by our real estate exploiters who at present control the flow of money to housing enterprises. This is well evidenced in Canada also, for we find that practically no advantage has been taken of the Ontario act to encourage housing accommodation in cities and towns, in which it is provided that a company incorporated under the Ontario Companies Act with a share capital, whose main purposes of incorporation are the acquisition of land in or near a city or town in Ontario and the building thereon of dwelling houses of moderate size and improvements and conveniences, to be rented at moderate rents, may petition the council of such city or town to guarantee its securities in order to enable or assist it to raise money to carry out such main purposes.

Six Per Cent. Insufficient

Section 12 of the Act is the obstacle. It reads: "No dividend upon the capital stock of the assisted company or other distribution of profits among the shareholders shall be declared or paid exceeding six per cent. per annum in any one year."

Why cannot some representative body, such as our bankers' associations, be requested to come forward frankly with a statement that for speculative purposes, to which we have relegated housing enterprises, six per cent. is not enough, and state what they deem is a proper percent. to attract the necessary money?

The first step in a forward move of this kind is to create a supervisor who will undertake the preliminary work, including compilation of statistics, much of which must be done by the municipalities themselves.

It is to be regretted that at the present time our municipal government, with the exception of one or two cities, is lamentably lacking in statistical information of any kind relating directly to the boards of health. No effort, even, is made to determine accurately the number of houses in the cities and towns in Ontario. A census is returned annually to the Department of Agriculture showing the assessment valuation of each town which, if properly prepared and analyzed, should yield information concerning

(Concluded on page 586)

THE NECESSITY OF ENGINEERING SUPERVISION IN THE CONSTRUCTION AND MAINTENANCE OF EARTH ROADS*

By H. Ross MacKenzie
Chief Field Engineer, Dept. of Highways, Saskatchewan

THE absolute necessity for engineer supervision in the construction of so-called "permanent" highways and large bridges is quite apparent to the average layman, but an erroneous idea is prevalent in Canada and particularly in Western Canada, to the effect that no special training or experience is required in order to supervise the construction of earth roads. This idea is one of the greatest obstacles in the way of securing better transportation facilities in the prairie provinces, and in the following brief treatise the writer shall endeavor to present a few of the many arguments in support of the contention that the construction of earth roads requires the supervision of competent engineers:—

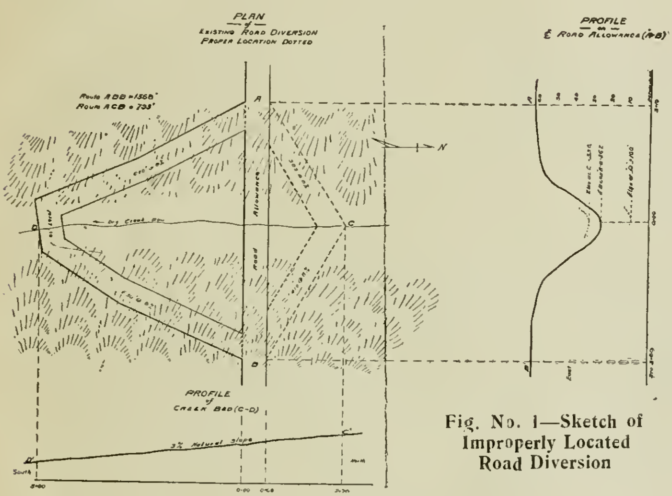

Fig. No. 1—Sketch of Improperly Located Road Diversion

The term "construction" as used in the heading of this article, refers not only to the grading of a road, but also to the location of required diversions, and to the installation or erection of the culverts and small bridges necessary to provide proper drainage facilities; and in view of the fact that Saskatchewan has not a single mile of "permanent" highway constructed in its rural area, this article applies generally to all road construction work in the province.

General Principles and Expert Opinions

Road building is divided into two parts, the theoretical and the practical, the one pertaining to the engineer, the other to the foreman or contractor. The engineer's duty is to design the road, having regard to cross-sections, gradients, alignment and drainage, whereas the duty of the foreman or contractor involves the direction of labor in an efficient manner.

We are still largely dominated in Canada by the belief that any ordinary capable man, possessing the necessary energy and ambition can do the work which should be done by a trained scientist. This belief is the direct result of rapid immigration to a country whose resources are abundant and where the absence of competition has enabled men lacking in scientific education to succeed in spite of crude and wasteful methods. This stage in the development of the prairie provinces is now passing; specialists in the various trades and professions are coming into prominence, and the public are beginning to realize that in road building, as in other construction work, the skill of the specialist is required. This awakening is largely due to the fact that although considerable sums are annually expended on road improvements, the ratepayers of the various municipalities find that the roads leading to their market centres are still in unsatisfactory condition.

The economic necessity of properly supervising the expenditure of funds for road construction, is well emphasized in a paper written by Adolph Edwards, who has had fifteen years' experience on road improvement work in the State of Florida. Mr. Edwards states that of the $300,000,000 spent on road improvement work in the United States during the year 1916, one-third was wasted. He adds that "this condition is the fault of the taxpayers primarily; they have not called for business-like administration and they have not received it.

"The pressing road problem of the country to-day is not so much to provide money for our highways and byways as it is to awaken the average taxpayer to a knowledge of the business side of the work for which he is contributing so liberally; that he may enlist the help of the ablest business men and the services of competent engineers in carrying it on. There is no question as to the correctness of this statement; the expenditure of road funds and the direction of road work by men of special training for the work is very often the exception, rather than the rule. Many a country has spent enough money to have good roads, but have poor roads because that money has not been judiciously expended. It is not a question of dishonesty in most cases, but of incompetency."

The startling statement made by Mr. Edwards regarding the waste of public funds on road improvement work in the United States, as a result of the lack of business-like administration and engineering supervision, is confirmed by Mr. Paul D. Sargent, who held the position of assistant director, U.S. Office of Public Roads, at the time when he made a statement to the Third International Road Congress held in London, England, in 1913, to the effect that during the period 1904 to 1913, practically $1,000,000,000 of local revenue was expended through the agency of 2,900 county officials and 19,000 township officials, with little, if any, permanent improvements resulting. We are safe in assuming that municipal officials in Canada are no better fitted to supervise road construction work than are the local municipal officials of the republic to the south of us, and any person familiar with road construction problems, travelling through our provinces can see instances on every hand where considerable funds have been expended without obtaining tangible results.

*Abstracted from paper before the Regina Branch of the Canadian Society of Civil Engineers.

Reference has already been made to the very definite manner in which individual men of broad experience in road construction work, have recognized the necessity of having such work supervised by competent engineers. We shall not examine the attitude of some of our Canadian provinces towards this matter, as expressed in the organization of their respective highway departments. In the neighboring province of Manitoba, the policy of road supervision is well outlined in the following extract from the 1916 Annual Report of the Good Roads Board:—

"All road construction is under the supervision of one of the good-roads engineers. Where the work justifies it an engineer is kept steadily in the district. Where the work is not sufficient to keep him employed all the time, the engineer stakes out the work and visits it from time to time to see that it is being properly carried out.

"No matter how small the amount of work performed in a municipality, a considerable expense is necessarily incurred for engineering purposes. Upon the engineering services and upon the inspection given to the work, depends largely the success and benefits resulting from the expenditure made."

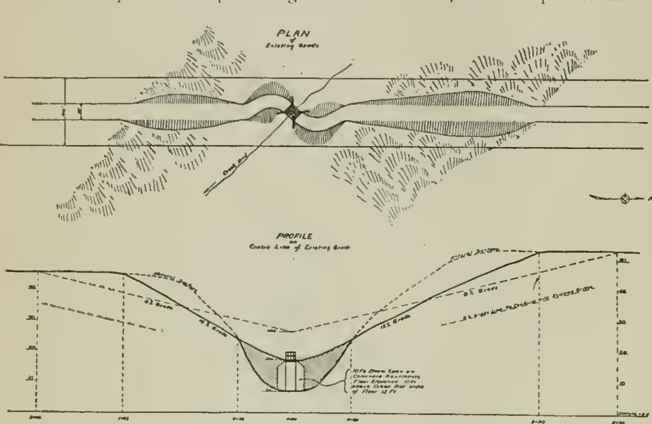

Fig. No. 2—Inadaptable and Unstable Bridge Design

In the province of Ontario the management of all road improvements under the Highway Improvement act, is centralized in a capable road superintendent or engineer, appointed by and acting under the direction of the county council. In an annual report on "Highway Improvements in Ontario," "supervision" is said to be the foundation stone on which road-building reform in Ontario must be based. County road systems with provincial aid are recognized as being very beneficial, but it is admitted that the greatest good will result from an awakening of the ratepayers, which will lead to all expenditure in the rural districts being supervised by men capable of applying scientific principles to the design and construction of a road.

In 1913 "an act to provide for the betterment of highways," was passed in the legislative assembly of the province of Nova Scotia. The first regulation for carrying out the provisions of this act reads as follows:—

"No work shall be commenced under this act, until a survey, report and estimate by a properly qualified engineer, have first been submitted to and approved by the commissioner of public works and mines."

The above reference to the attitude of other Canadian provinces in the matter of scientific supervision of road construction is sufficient for the purposes of this article, in view of the fact that the provinces mentioned are among the foremost supporters of the good roads movement in Canada. In the American republic, where earth roads comprise 90 per cent. of the total mileage we find that twenty-six states have divisional engineers, who supervise the construction and maintenance of all "State" and "State-aid" roads; many of the remaining states have a sufficient number of highway engineers in their employ to supervise the construction of all main highways.

Classification of Errors

The attitude of experienced individuals and progressive governments regarding the necessity of engineering supervision of road construction, is the direct result of the many concrete examples of poor location, faulty design and wasted effort, which are to be found on the roads in our rural districts. During the six years that the writer has been connected with highway improvement work, he has had the privilege of examining a great deal of road construction in the various parts of this province, and reference shall now be made to the most common classes of errors which have been observed and which are due to lack of engineering supervision.

The most frequent error in road construction work in this province is the adherence to road allowances when suitable grades cannot be obtained or where the cost of improvements are excessive. Many thousands of dollars are wasted every year in this class of road construction and in addition to the actual cost of such work there are accumulating losses, due to restricted tonnage and excessively high maintenance charges. Many such roads in this province have grades of from 10 to 18 per cent. and eventually they are abandoned in favor of new locations where good grades can be obtained, often with the expenditure of a less amount than was wasted in attempting to adhere to original location. Had engineering advice been obtained before construction was undertaken a profile of original road allowance would have shown that suitable grades were not obtainable.

When it has been decided to abandon the regular road allowance at some particular point, unskilled road builders often make grave errors in locating diversions. These errors are largely due to disregard of natural topographical features, and a concrete example of an improperly located road diversion is shown in Fig. 1. At this point a ravine 37 feet in depth, and roughly 400 feet in width, and having a natural fall southward of 3%, traversed an east and west road allowance at right angles. With total disregard of the natural fall of the ravine bottom, the diversion was constructed on the south side of the road allowance, as shown on solid lines on plan. The total length of the diversion A D B is 1,368 feet, whereas if the diversion had been located as shown on dotted line, the same per cent. grade would have been obtained with a total distance A C B of 795 feet, *i.e.*, by taking advantage of the natural topographical features, we would secure an unusually good grade with a saving in distance of 373 feet and corresponding savings in initial cost and maintenance of road. The fact that the point C is 23.8 feet higher than the point D would mean a saving

in energy which would appreciably affect the cost of transporting produce over this road.

Defective Culverts and Bridges

The construction of culverts and bridges of insecure design, unsuitable type or insufficient capacity, constitutes one of the most serious errors in road construction work, performed under the supervision of men lacking technical education. Errors of this nature, apart from being a waste of public funds, sometimes result in serious accidents. Numerous motor cars have been wrecked and many valuable horses killed as a result of defective culvert and bridge construction.

The designer of culverts and small bridges, not only requires a knowledge of the strength of materials, but should be able to calculate the maximum run-off from a catchment basin in cubic feet per second in order to determine intelligently the drainage capacity required. The installation of culverts and bridges of insufficient capacity not only results in the loss of the structures themselves, but invariably means considerable loss of embankment and serious inconvenience to the travelling public. The determination of the most suitable type of culvert or small bridge requires considerable engineering experience. We find frame-bent bridges on marshy ground and over swift-flowing streams, concrete bridges without the necessary foundation to prevent heaving, and deck spans where the height of embankment requires a concrete or corrugated iron culvert. Grave errors in location of culverts and bridges are also prevalent.

Without going into further details of the many errors made in culvert and bridge construction, we shall refer to Fig. 2, which is an actual example of bridge construction combining inadaptability with unstable design and faulty workmanship. At this location a ravine of 40 feet in depth crossed the road allowance at an angle of 45 degrees. Two concrete abutments 10 ft. in height and with 10 feet between face walls, were constructed parallel to the creek bed. These abutments supported a timber deck 12 feet in width and with the usual guard-rails, leaving a clear roadway of slightly over 11 ft. The lack of stability was due to the absence of footings, or any kind of foundation for the abutments. The concrete was of very poor quality as a result of using sand containing a large percentage of loam, and when the back-filling was in progress the wing-walls collapsed. This type of bridge, even if properly designed and well constructed, would not be adapted to this location, in view of the fact that a 19-ft. fill was required to provide a serviceable grade. To construct 19-ft. concrete abutments for a 10-ft. span would be obviously ridiculous. The method adopted by the writer to improve this crossing was to remove the flooring of span, place a 6-ft. corrugated iron culvert 60 ft. in length between the abutments and raise the fill 9 ft. above floor level of old span. By this method the road was straightened, the grade reduced from 15% to 8%, and the mistakes of a man who is a successful farmer but an amateur road builder, were disposed of, after the manner sometimes attributed to the medical practitioner.

Profiles are Important

The lack of continuous fall in side ditches is a serious error in road construction work. Often the ditches are dug deeper at the lower points because more material is required to make the fill. The resulting pools saturate the foundation of the road and heavy traffic will then cause the road surface to become badly rutted. Profiles of all ditches should be prepared in order to secure continuous flow to the point of outlet whenever possible.

Another error due to the absence of profiles for the guidance of road foremen, is the improper determinations of the point at which the assumed grade line intersects the natural surface of the hill, in order to give an economic balance between cut and fill. The writer has observed many instances where excavation was commenced at a point too near the foot of a hill, with the result that when the road was properly improved part of the original excavation had to be refilled. The construction of grades of uniform height across periodically flooded areas assumed to be level, but which in reality present difference of elevation of two or more feet and vice versâ, the construction of grades of varying height across low areas of almost uniform elevation, are further evidences of the necessity of cross-sectioning road construction work, in order to prevent waste of material and unsatisfactory results.

Side-Borrowing vs. End-Haul

One of the principal errors of an economic nature is "side borrowing" in cases where "end-haul" would be cheaper when the general improvement of the road is considered, and vice versâ, the construction of a fill by "end-haul" when "side-borrowing" would be more economical. The writer once observed a road foreman who had several years' experience in railway construction work undertake the building of a fill across a U-shaped ravine by side-borrowing in the bottom of the ravine. When the fill got so high that he was unable to continue this method, he resorted to the proper method of excavating on each bank, and depositing the material in the fill. Before the fill attained the required height the side slopes extended so as to completely fill the borrow-pits. The lack of economy in making an excavation for the purpose of refilling it, is apparent. This foreman had been accustomed to following the grade stakes set by an engineer, but when thrown upon his own resources he was entirely incapable of constructing a road in an economical manner; and although the case referred to may be a particularly striking example of this class of error, still, numerous cases exist where an unusually great waste of funds resulted from the adoption of the wrong method in the construction of a fill.

Six Outstanding Errors

Numerous examples of other classes of errors might be given, but it is not the purpose of this article to exhaust the subject nor to deal to any extent with the features which refer more to the execution of the work than to the design. The classes of errors already referred to embrace the most prevalent and outstanding examples of faulty road construction in Saskatchewan, due to the lack of engineering supervision, and these errors can be briefly classified as follows:—

(1) Too rigid adherence to road allowances.
(2) Disregard of topography in relocation.
(3) Improper location and construction of culverts and small bridges.
(4) Ill-designed ditches.
(5) Naked-eye levelling of heavy cuts and fills.
(6) Improper use of "side-borrow" and "end-haul."

Qualifications of Road Supervisors

Having enumerated the principal classes of errors in road construction, we can now summarize many of the required qualifications of road supervisors, as to the ability to eliminate these errors. The road supervisor should not only be able to determine the best possible

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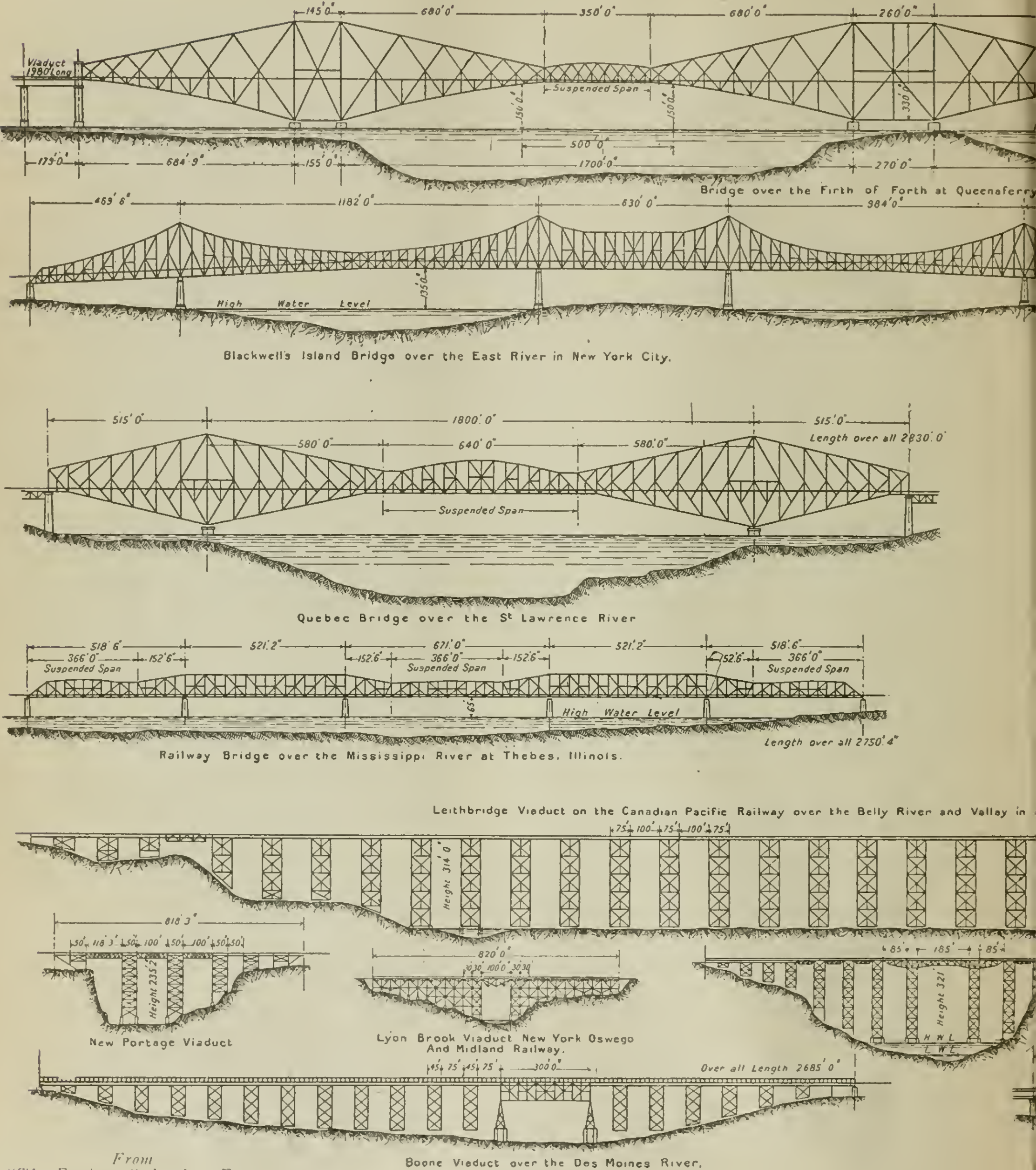

From
"The Engineer," London, Eng.

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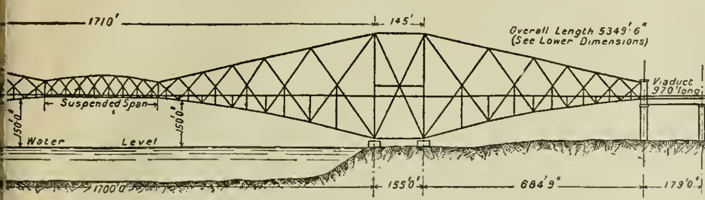
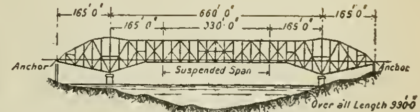
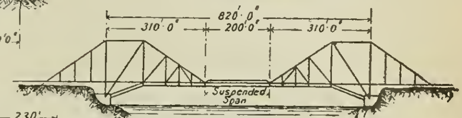
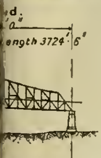


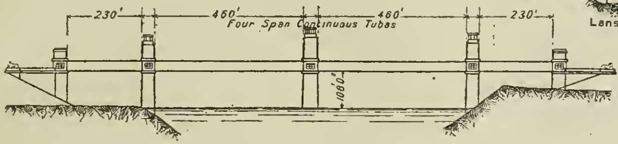


Red Rock Cantilever Bridge over the Colorado River.

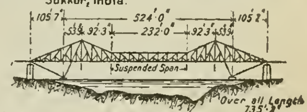


Lansdowne Bridge over the Indus River at Sukkur, India.

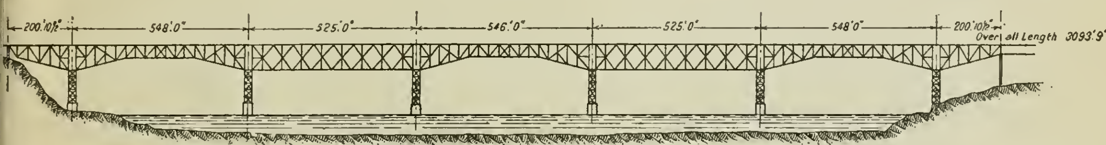




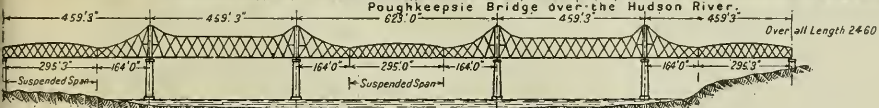
Britannia Bridge over the Menai Straits.



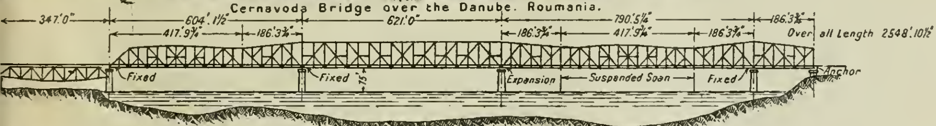
Connels Ferry Bridge. Loch Etive, Scotland.



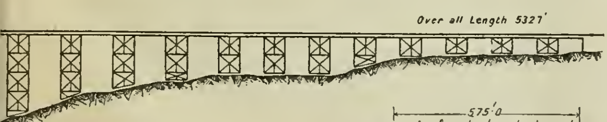
Poughkeepsie Bridge over the Hudson River.

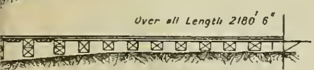


Cernavoda Bridge over the Danube. Roumania.

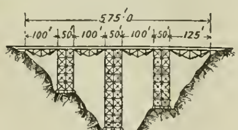


Railway Bridge over the Mississippi at Memphis. Tennessee.

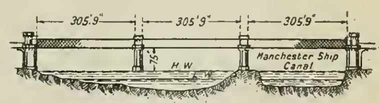




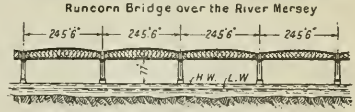
Viaduct. Southern Pacific Railway.



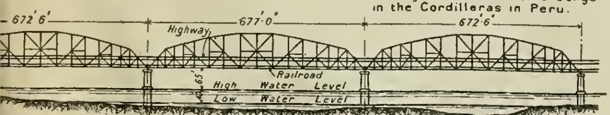
Verrugas Viaduct over a Gorge in the Cordilleras in Peru.



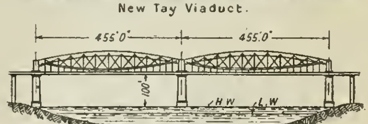
Runcorn Bridge over the River Mersey



New Tay Viaduct.



Free Bridge over the Mississippi River at St Louis. Mo.



Saltash Bridge.

NECESSITY OF ENGINEERING SUPERVISION

(Continued from page 573)

location of a road and to design and construct the necessary culverts and bridges, but he should have such scientific knowledge as would enable him to maintain it in the most economical manner. This means a thorough technical training and years of practical experience.

Road construction and maintenance require of the engineer qualifications of just as high order as would be demanded in the case of an engineer required to supervise the construction of railways and canals, for the problems to be solved are exactly analogous. Thomas Adams, of the Commission of Conservation, states that "road planning and engineering is a highly skilled profession and millions of dollars are wasted in the attempt to save money that should be used to employ good men to design the location and construction of roads." Scientific determination of the proper location of a road involves a knowledge of the road-building value of various kinds of soils, and the design of sub-drainage requires familiarity with certain geological features, hence it is evident that the road supervisor requires a very liberal education.

Permanent Road Supervisors Needed

During the past year several municipalities in Saskatchewan for the first time employed engineers to supervise their road construction. Sherwood municipality has led the way in appointing a road supervisor at an annual salary, and the writer is confident that in the near future the ratepayers of the various municipalities will realize that so long as municipal councillors rotate in office from year to year, their services as road supervisors consist of a series of experiments by which they gain their experience at the expense of the people. If there is need for a permanent secretary-treasurer, there is still greater need for a permanent road supervisor, possessing the necessary technical training to enable him to locate, construct and maintain public highways in an efficient manner.

Road Supervisors Should Be Trained Engineers

It is true that there are many good road builders who have not graduated from technical schools, but these are exceptional and their experience is restricted to a narrow line of work, and their usefulness is curtailed by their limited education. Outside the range of their experience they have to depend on analogy and in so far as their education is incomplete they lack in efficiency. In the opinion of the writer, a thorough technical education is primarily necessary to properly equip a man as a road designer and builder. A general knowledge of the principles of engineering practice can be obtained by field experience, but an education obtained in this manner has certain restrictions to which reference has already been made. Having received a technical education preferably by a systematic course of training in an engineering school, years of practical experience on highway work is desirable, if not essential, to produce the proper balance between theory and practice. The personal characteristics of the individual largely determine his prominence in this as in any other profession, but generally speaking, it may be said that road supervisors should be engineers first and highway engineers afterwards.

If repairs are to be made to the Gatineau Point Bridge at Hull, P.Q., the work will have to be done by the city, as the city clerk has been notified by the Department of Public Works of Canada that the department does not propose to contribute toward its repair.

REINFORCED CONCRETE FOR SHIP CONSTRUCTION*

By Major Maurice Denny, A.M.I.N.A.

So long as the efficiency of a mercantile marine is judged by its dividend-earning capacity in free competition, so long will the choice of material for the construction of its units depend on economic considerations.

Up to the present, for the general trader, steel has proved to be the material which gives the greatest return for capital invested, and no material inferior in this respect will permanently displace steel from this position.

In the abnormal circumstances now prevailing, however, when free commercial competition is suspended, it is not necessary to examine the suitability of a material solely from the monetary point of view, and any substance which swells the volume of tonnage by drawing on fresh sources of labor and material has a chance to prove its

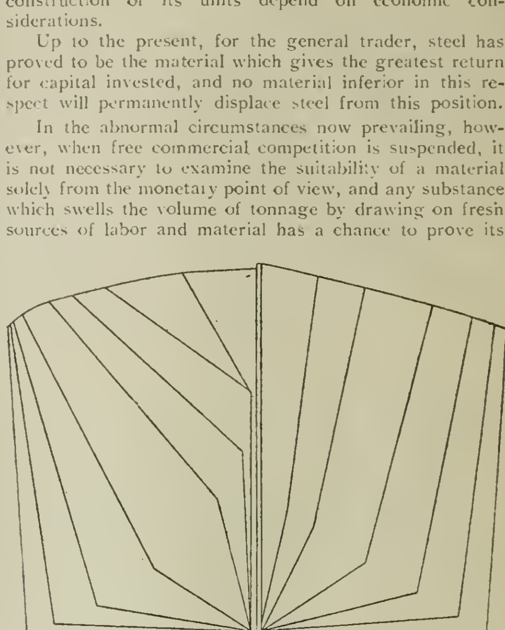


Fig. No. 1

merit on technical grounds alone. Reinforced concrete at once suggests itself as an alternative to steel, its suitability for general structural purposes being everywhere evident on land, and its application to floating structures being no longer entirely novel.

For all structures such as beams, reinforced concrete is particularly suitable, the steel taking tension and the concrete bearing compression. As almost every part of a ship's structure may be considered to be a beam under load, reinforced concrete is therefore not fundamentally unsuited to ship construction. When it is added that the use of reinforced concrete makes practically no demand on the class of labor and material used for steel shipbuilding, the justification for its trial is sufficient, and, in these times, overwhelming.

Experience has proved that steel embedded in concrete is completely protected from corrosion. The principal source of deterioration in a steel ship is consequently removed, and the saving of steel shown in comparing a reinforced concrete vessel with a steel ship of the same dimensions must be partly credited to this fact.

The repairing of local damage in a reinforced concrete ship would seem to be a relatively simple matter. So soon as sufficient concrete and steel in way of the damage has been removed to allow of an adequate "scarph" between

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*Abstracted from a paper read before the Spring Meeting of the Institution of Naval Architects, 1918.

old undamaged and new reinforcement, fresh concrete can be poured into place. Since concrete sets under water it is not necessary to retain the vessel in dry dock during the initial stages of hardening. The actual time required for weathering will depend on the structural importance and extent of the damaged portion, and unless this is considerable, the vessel can return to service after a much shorter lapse of time than was necessary between launching and delivery.

Methods of Waterproofing

Watertightness is one of the points which the naval architect will most critically examine when the question arises of replacing steel by reinforced concrete. Fortunately, experience of large tanks in land work is by no means limited, and it is possible to draw certain inferences from the behavior of these structures. Apart from the water-resisting ability of simple concrete there are various methods of treating the material which fall generally into two categories: (1) The addition to the concrete during mixing of a waterproofing compound; (2) The treatment of the finished surface with a suitable non-porous material. The first of these is generally believed to reduce the strength, and in the present position of the industry the naval architect will be chary of adopting it. The second comprises the treatment of the surface with cement mortar well rubbed into the pores, coating with a special mixture, and painting as in a steel ship. It is interesting to note that, even in this early stage of development, reinforced concrete vessels are being built to carry fuel oil in bulk, experience with land storage tanks and experiments recently made indicating that mineral oil has little or no destructive effect on the material.

The ability of reinforced concrete to stand vibration, whether from propelling or deck machinery, may be called in question. The experience afforded by railway bridges and factory floors shows that little trouble need be feared from this cause, provided that the concrete is not allowed to fail progressively by unsuitable distribution of attachments.

Concrete when being worked in a plastic material; the processes of construction partake more of the foundry than of the shipyard, and the moulds required in a foundry equally have their place in the reinforced concrete shipyard. It is evident that the quantity of material required for the moulds is great, and the labor required for their erection will bear a considerable proportion to the total labor required for the ship. It is therefore an obvious economy to arrange that several vessels shall be cast from the same moulds. This has a marked effect on standardization of type. Where wood is used for the moulds it will probably be found that from five to eight vessels can be built from one lot of shuttering, though considerable repairs and renewals to the woodwork will only be avoided by skilful design and care in erection and dismantling.

To Avoid Intricate Forms

It seems evident that if the usual ship form be adopted, in which there is curvature in two directions, the amount of work entailed in shaping the shuttering will be at its maximum. The minimum amount of shaping will be given by a rectangular box; but as such a form is usually inadmissible a compromise must be effected. The best result from the point of view both of the naval architect and the reinforced concrete engineer must be sought among the class of "straight frame" forms, which yields at once reasonable figures for resistance in association with curvature in one direction only. Two suggested compromises are shown in Figs. Nos. 1 and 2, the "batter" of the sides in Fig. No. 1 being given in order to reduce the chances of possible damage at the sharp bilge when lying alongside quay walls, and in the case of Fig. No. 2 to secure "flare" at the bows.

The inspection of a reinforced concrete vessel just prior to the commencement of pouring is apt to produce in the mind of the naval architect an impression other than favorable. The unfamiliar network of rods scarcely suggests serious shipbuilding, and the idea that these should be replaced by the more usual and substantial sectional material at once presents itself. In the case of the frames, for instance, two angle bars connected by light bracing would appear to possess the same strength as the rods, in combination with greater ease of erection and immobility during pouring. This system, however, would relegate the concrete to the inferior position of a mere cover for, and support to, a complete steel structure, and would be a return to a method long discarded by reinforced concrete engineers. It would seem a fundamental error to cling to methods of construction found suitable in one material when dealing with another material of a totally different character.

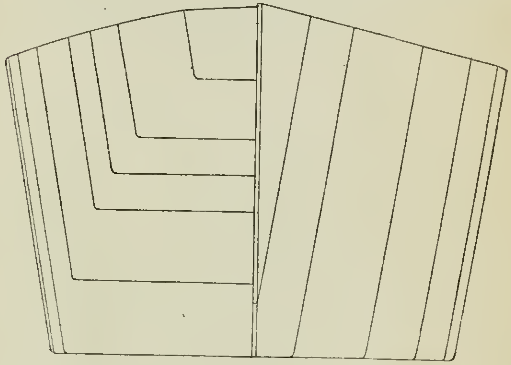

Fig. No. 2

The majority of present-day reinforced concrete designs are based on the production of a vessel which should be cast in one operation, the "monolithic" method, and the foregoing remarks on construction primarily have reference to a monolithic ship. The alternative method is to cast the integral parts separately and assemble them at the slip—the "sectional" method.

In the "sectional" method, portions of the structure more or less extensive are cast from moulds which should be capable of being used a large number of times. A vessel whose sides have irregular curvature, or one in which there is no great extent of parallel middle body, is evidently ill-suited to this form of construction. The sections are assembled in place, and in addition to grouting, steps must be taken to provide for continuity of the local reinforcing material. As it is impossible to allow the general longitudinal reinforcement to be broken abruptly, it is obvious that it cannot form part of the sections, and must therefore be placed in position separately from them. After the sections are assembled, the longitudinal reinforcement at gunwale, bilge, etc., would be placed and the concrete poured round it.

The launching of a vessel subjects the structure to local stresses which may be of considerable magnitude. By constructing the vessel in such a situation that she

may be waterborne without subjecting her to stresses as severe as those imposed by launching, the necessary period of delay between the completion of pouring and floating is reduced. The advantages of floating from a dock, however simple or elaborate it may be, as distinct from launching are:—

Launching vs. Floating

(1) The possibilities of failure of the structure during removal from the building berth are much reduced.

(2) The number of berths required to execute in a given time any programme is reduced owing to the fact that the number of ships lying "weathering" on dry land is less.

(3) The ground can be permanently levelled and prepared so as to form the exterior surface of the bottom shuttering, whereas bottom shuttering is always required (at least in a monolithic vessel) where launching is contemplated.

It should be noted that given equal speeds of construction the time from laying of keel to delivery to owners will be the same under either method, if, as is essential, the strength on the maiden voyage is to be the same in both cases. In the future, the choice of method will be determined by the financial considerations governing the acquisition and development of the building site.

In the present early stage of development it is natural to expect that widely differing estimates of weight, both as regards concrete and reinforcement, will be advanced by various engineers for the same ship; any one dealing with reinforced concrete vessels to-day has constant evidence of this. But it is found, as might be expected, that the percentage of reinforcement steadily increases with size of ship. Thus, average figures for percentage weight of steel to total weight of reinforced concrete are, for a 500-ton barge 11 per cent., for a 1,000-ton barge, 14 per cent., for a 6,000-ton steamer 22 per cent. This last figure corresponds to a percentage area of steel to reinforced concrete of about 7 per cent., and when it is recalled that an average figure in land work is about 1 per cent., the much more onerous requirements of marine construction are again emphasized.

Deadweight and Internal Volume

The shipowner is chiefly interested in the loss in deadweight-carrying ability. If a vessel of the same dimensions as the 1,000-ton concrete barge noted above had been built in steel, she would have carried somewhere between 35 and 40 per cent. more deadweight.

The quantity of steel required in this reinforced concrete vessel is less than one-third that used in the steel ship, but the finished hull weight is nearly twice that of the latter, even when allowances have been made for the omission of cement and paint in the heavier ship. Where internal volume is the measure of the carrying capacity of a vessel, this increase of weight, though not without its drawbacks, is not vital, but where deadweight is the governing factor, the advantages are heavily in favor of the steel structure.

A detailed comparison of the technical particulars of the 6,000-ton deadweight steamer mentioned above will be of interest. It is observed, however, that while the figures quoted for the steel ship are probably accurate, the weight of the reinforced concrete hull is purely estimated, represents a much larger vessel than has yet been attempted in the new material, and lacks the confirmation of practice.

	Steel.	Reinforced Concrete.	
Length	375 ft.	375 ft.	
Displacement	9,900 tons	9,900 tons	
Steel	1,920 tons	680	3,150 tons
Concrete	—	2,470	
Wood and outfit	400 tons	350 tons	
Machinery	570 tons	570 tons	
Lightweight	2,890 tons	4,070 tons	
Deadweight	7,010 tons	5,830 tons	

From the above it will be noted that 1,180 tons of deadweight is lost, or 17 per cent. of that carried in the steel ship; that the bare hull of the concrete ship is 65 per cent. heavier than that of the steel ship, and that the lightweight of the concrete ship is 40 per cent. greater than that of the steel ship.

It is impossible to state exactly to what extent the loss in deadweight will restrict the application of reinforced concrete to the construction of cargo carriers, since the cost of construction in reinforced concrete is still somewhat conjectural, but it can be stated with fair certainty that reinforced concrete will not replace steel for the ordinary cargo carrier unless the hull can be built for considerably less than half the cost of building the same hull in steel.

The Future for Concrete Ships

In spite of this there appears to be a class of floating structures in which reinforced concrete may well replace steel. Where the additional weight is more than counterbalanced by the durability and reduced prime cost of the new material, there is reason to expect that its adoption will naturally follow.

There would, therefore, seem to be a future for reinforced concrete in such structures as lightships, floating docks, landing stages, hulks, depot ships and similar craft, and it may confidently be expected that even when the artificial stimulus to reinforced concrete construction provided by present-day conditions is removed, the industry will still persist on the sound footing of commercial and technical suitability.

HAMILTON ENGINEERS ORGANIZE

At the organization meeting of the Hamilton Branch of the Engineering Institute of Canada, J. L. Weller, formerly chief engineer of the Welland Canal, presided. The meeting was held in the Connaught Hotel and was attended by about forty engineers, including some from St. Catharines and Niagara Falls. The latter attended to protest against the formation of the branch, being under the impression that all members within fifty miles would be forced to join the new branch, whereas they preferred to retain their non-resident membership in the Toronto Branch. They found, however, that the bylaws of the institute do not require members residing further than twenty-five miles from any branch to belong to that branch.

It was definitely decided to organize, and a formal petition was signed to be forwarded to the council of the institute at Montreal. E. R. Gray, city engineer, was appointed temporary chairman, and E. H. Darling, consulting engineer, was elected temporary secretary.

It was suggested by John H. Jackson, engineer of the Niagara Falls Victoria Park Commission, that another branch might be formed at Niagara Falls, Ont.

REINFORCED-CONCRETE FLAT-SLAB RAILWAY BRIDGES*

By A. B. Cohen
Assistant Engineer-in-Charge Concrete Design, the Delaware, Lackawanna and Western Railroad, Hoboken, N.J.

THE art of reinforced concrete had its inception in Europe and flourished there for a number of years before taking root in this country. Although the development here has been of the highest order, there are foreign precedents for a major portion of the various uses for which we have structurally combined steel and concrete. The style of our American design has differed from that of the European to meet the widely different economic conditions of labor and of materials. With limited labor and abundant resources—the reverse has been true in Europe—our efforts have been concentrated, in a general way, toward the simplification in design and expedient methods in erection. The results are exemplified in no greater instance than in the development of the girderless floor, better known as flat-slab construction, where the simplicity has been so perfected as to produce the extreme European effort in conservation of materials without the excessive expenditure of time and labor incident thereto.

One has only to mention the recent astonishing record, seemingly incredible, made by the use of the flat slab in the erection of the Brooklyn Naval Storehouse, to prove conclusively its remarkable utility. This eleven-story building frame covering a ground area of 180 x 260 ft., or 1½ acres, was completed in 14 weeks by 500 men working one shift a day. The building, entirely fireproof, is capable of holding 70,000 tons of supplies.

Other building achievements could be mentioned to show the extraordinary development and utility of the flat-slab system for light building loads. It is the object of this paper, however, to show that the flat slab can be utilized, with equal effectiveness and added advantages, in carrying heavy railway loadings in the construction of viaducts and especially bridges of lesser magnitude where the required span length is not prohibitive. All forms of concrete construction have this limitation.

The principal advantages of the flat slab compared with all other forms of reinforced concrete and other fireproof construction are embodied in the simplicity of both

Fig. No. 1—Lackawanna Railroad's Buffalo Terminal

the formwork and arrangement of the reinforcing steel. The first cost of construction has been so reduced thereby as to put structural steel, in competition with the flat slab within its limitations, substantially out of consideration; furthermore, with the concrete construction lower maintenance charges prevail and greater permanency is obtained. The simple arrangement of the reinforcing steel, laid over a practically unbroken flat surface, insures a more positive placement of the reinforcing bars than the general beam and slab design in concrete.

In addition to these general advantages of the flat-slab construction, the salient advantages resulting from its

*Paper read at convention of American Concrete Institute, June 27th-29th, 1918.

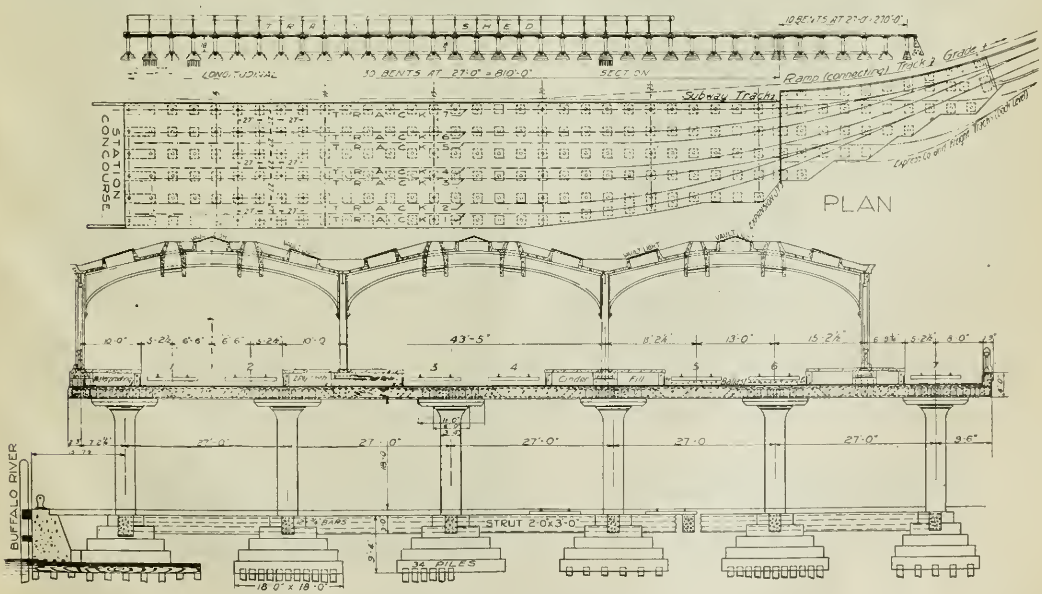

Fig. No. 2—Details of Reinforced-Concrete Flat-Slab Trainshed of Lackawanna's Buffalo Terminal

adaptation to railway structures will be brought out in subsequent description and illustrations of actual examples. There is, however, one outstanding feature of the flat-slab system which in the writer's opinion is of most vital importance in reinforced-concrete construction. By reason of its uniform cross-section and continuity of the reinforcement, there is no other type of reinforced concrete that is better proportioned to resist shrinkage and thermal changes. Structures of the flat slab have

Fig. No. 3—Flat-Slab Bridge Carrying Lackawanna at South Orange Station

been built in surprisingly great lengths without the incorporation of a single expansion joint and have successfully resisted the very severe strains of these stresses. By the insertion of an additional amount of reinforcing steel across construction joints, a constant tensile resistance can be maintained which has the effect of preventing cumulative action of the stresses at any particular section; the strain is distributed uniformly throughout, resulting in an infinite number of minute cracks that do not impair the strength of the structure.

Our experience does not extend over a sufficient length of time to ascertain definitely what effect the repeated action due to temperature changes will eventually have on the strength of the structures. However, very close observation of existing flat-slab structures, in service from three to six years, have disclosed no deleterious effect due to these causes. The minute cracks found were of no greater concern than those developing on the tension side of a beam long before the steel has reached full working stress.

By way of comparison in this regard, to show the difficulties encountered in other types of concrete construction, consider the special arrangements in the manner of expansion and sliding joints that are necessary and not always efficacious in large concrete-arch viaducts or in viaducts of the column, beam and slab design. In the viaducts consisting of a series of large main arches surmounted by transverse spandrel walls supporting a floor system, the vertical movement of the heavy arch ring, for a rise and fall of temperature, is transferred to the floor system. This very appreciable vertical movement must be resisted by the comparatively light floor in addition to its own changes in a horizontal plane. In the case of the beam and slab design the constituent members have different sections and therefore offer varying degrees of tensile resistance. There arises the difficulty of transferring the movement from the larger through the smaller members, as from the deep beams through the thin slab, which is not always satisfactorily controlled.

Soo Line Terminal at Chicago

In 1912-13 the first and so far the most extensive application of the flat-slab system for carrying railway loadings was made in Chicago with the erection of the Soo Line Freight Terminal.

The yard area required for this improvement amounted to $18\frac{1}{2}$ acres, comprising eleven city blocks located near the business and manufacturing centres. This entire layout for handling freight is carried on an elevated structure to meet the municipal requirements that no grade crossings should exist. Deck construction gave the greatest possibilities of storage development, making available 520,000 sq. ft. on the ground surface underneath the deck for this purpose. The flat slab showed advantages of lower cost, lower maintenance and greater permanence as compared with structural steel. From a railroad point of view the outstanding feature of the design is

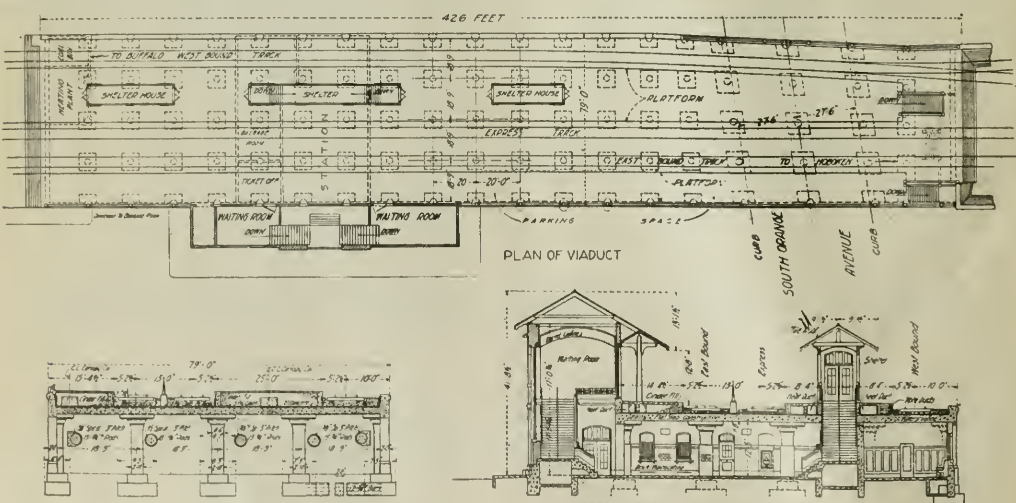

Fig. No. 4—Details of the South Orange Structure

the possible flexibility in the track layout since the structure is designed to carry any arrangement of tracks on 12-ft. centres. This was obtained with very little additional cost over a fixed position of tracks and driveways. It was in this structure that those responsible for the design decided that no expansion joints were necessary and their judgment seems to have been justified.

D., L. & W. R.R., Buffalo, N.Y., Terminal

The highly satisfactory results obtained with the flat-slab system at the Soo Line Terminal prompted its consideration and adoption by the Delaware, Lackawanna and Western Railroad in the recent construction of a viaduct approach to the station of the new terminal improvement at Buffalo, N.Y. (See Fig. 1.) The viaduct, 154 ft. in width and 1,070 ft. in length, supports a structural steel trainshed, platforms, and seven tracks on ballasted floor. This is shown in plan and cross-section (Fig. 2). For reasons analagous to those cited in the first example, deck construction was admirably adapted to the maximum development of full terminal facilities in a very limited area. This new layout is located alongside the Buffalo River. Docking facilities are for Great Lake steamers which can be unloaded directly under cover of the slab where storage and other shipping facilities, including the express companies, are available. Two tracks are located on the dock level which connect by means of the subway and ramp tracks, with the main line tracks on the upper level. Passenger traffic is discharged on the upper level precluding interference with other station appurtenances best located on the ground level.

The entire structure is supported on timber piles and gravity footings. A precautionary measure was taken to prevent possible movement of piles by connecting all the piers in both longitudinal and transverse direction with reinforced-concrete beam structs or ties, thus insuring lateral stability. Single drop panels connect corresponding columns of bents 1 and 2 to reinforce the end section

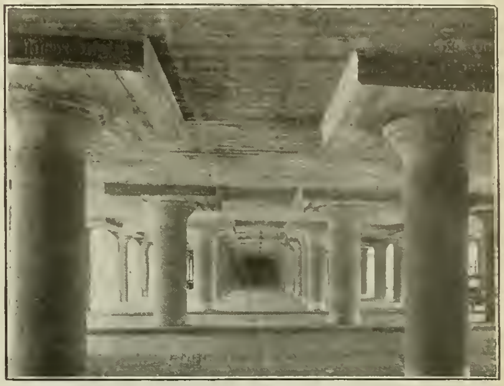

Fig. No. 5—Underside of Slab at South Orange

to take impact transferred from the bumping post which is anchored to the slab. The perfectly flat unobstructed floor simplified the waterproofing treatment which consists of a membrane composed of two layers of cotton cloth saturated and applied with hot asphalt and protected by a cover of asbestos paper and two ¾-in. layers of

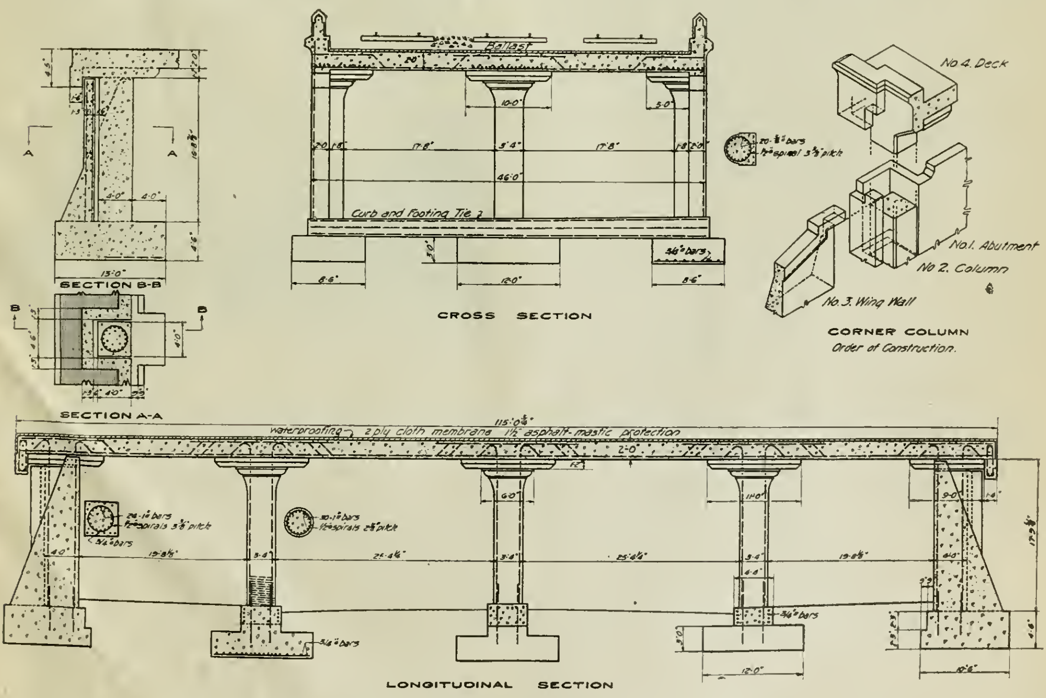

Fig. No. 6—Details of Bridge at Central Avenue, Orange, N.J.

asphalt mastic. Only one expansion joint was provided and this placed at bent 31 where the slab begins to narrow down from the seven-track to the two-track width at the easterly end. The joint was deemed necessary here for the reason that the narrow section would not offer the same tensile resistance to temperature changes as would the wider section. An accumulation of stress might reasonably be expected somewhere in the narrow section if no expansion joint were provided which might result in cracks of sufficient magnitude to impair the strength of the viaduct.

It might be noted here that the only cracks so far developed have occurred in the side panel under tracks 1 and

Fig. No. 7—View of the Central Avenue Bridge, Lackawanna R.R.

2 between bents 24 and 25. The principal crack starts at a point where the centre line of track 3 intersects the side of the drop panel of column in bent 24 and bows out slightly in the arc of a circle to about the third point of the panel, ending at the intersection of the centre line of track 1 with the side of the drop panel of column in the same bent; another break forms almost normal to this main crack radiating from it and continues parallel with and about four feet off the centre line of track 1. This crack extends completely through the centre of the large drop panel common to the two outermost columns of bent 25, but like the main crack does not seriously impair the strength of the slab.

A plausible explanation of the cause of the cracking which happened before any live-load was applied might be advanced. This section was poured July 14th, 1916. The waterproofing was laid during the following winter and it was on this panel that the kettles for melting the asphalts were placed, resulting in high temperatures in the slab. There is the possibility that the subsequent sudden cooling of the slab in zero weather caused the cracking above described. Sudden atmospheric changes of wide range are common in locality around Buffalo.

This hypothesis is not advanced so much in an endeavor to substantiate the writer's previous remarks—that the constant tensile resistance of the slab under ordinary conditions has the effect of preventing cumulative action of the stresses at any particular section—but is given rather for its value as a warning in anticipation of what may occur to any concrete bridge slab if too much heat is applied locally in extreme cold weather to comparatively thin slab for whatever may be the purpose.

South Orange Station Viaduct

The second application of the flat-slab construction made by the Delaware, Lackawanna and Western Railroad solved in a very acceptable manner one of the perplexing problems encountered in grade crossing elimination through populous sections. The difficulty develops when it becomes necessary to acquire abutting property for the expansion of tracks and station facilities, in which case the property is usually rated at an exorbitant value.

This condition prevailed in connection with track elevation work through South Orange, N.J., where the acquisition of more right-of-way would have been necessary for an additional third track and island platform together with a new station if the latter were to be built in the usual manner alongside. The necessity of purchase was obviated advantageously by the adoption of a flat slab viaduct, 79 ft. in width and 426 ft. in length, under which the station and all its appurtenances were built within the confines of the original right-of-way. (See Figs. 3, 4 and 5.)

The proximity of South Orange Avenue, a county highway, was an important consideration in favor of the slab construction since the easterly end of the viaduct is carried over this main thoroughfare. Included in the facilities provided under cover of the slab are a concourse connecting the station with the avenue and its trolley line, parking space for vehicles, a baggage platform and a heating plant apart from the station.

In addition to the three tracks, the viaduct carries an eastbound platform 14 ft. 4½ ins. in width and a 25-ft. island platform between the middle or express track and the westbound local. The 25-ft. width was fixed by clearance requirements on either side of the shelter houses built on the platform.

There are many advantages in addition to that of economy to be gained by this type of construction. It permits of more effective architectural treatment; because of its shallow floor depth the track can be laid in ballast which is a very important consideration in track construction; there are no girders projecting above the deck to encroach upon the lateral clearance of the motive power or to interfere, as in this case, with the construction of the platforms; the rigidity of the structure is noteworthy since no noticeable vibration is developed with the simultaneous passing of heavy locomotives at high speeds on

Fig. No. 8—Waverly Place Bridge at Madison, N.J.

all three tracks; by reason of this rigidity and of the ballasted floor, the rumbling noises common to structural steel bridges are very much subdued.

Central Avenue Bridge, Orange, N.J.

In continuation with the improvement through South Orange, and following extensive plans to eliminate all grade crossings through its highly developed suburban sections in New Jersey, the Lackawanna Railroad has elevated tracks through the adjoining City of Orange. Here twenty-three more or less dangerous crossings have been eliminated. In this work concrete was used almost exclusively in the construction of bridges.

The same advantages that accrue from the use of flat-slab construction covering large areas prevail for smaller structures. Fig. 5 and Fig. 6 illustrate its application to

a small type three-track bridge built on the Orange Improvement over Central Avenue, 100 ft. in width. Columns on the curb and along the centre line of the driveway divide the deck into eight rectangular panels, two in the width and four in the length of the structure, with dimensions as shown in cross-sections of Fig. 6.

The simplicity of the structural details of the flat slab offers an opportunity to correct the troublesome conditions encountered in bridge abutment construction. The writer calls attention to the abutment development of the Central Avenue Bridge which resulted from the conception of maintaining throughout the deck the positive plate action attributable to the flat slab. This was to be effected by an end column support to replace the somewhat complex action in supporting the slab on the full width of the abutment. The columns are set in recesses built in the abutments as shown in sections A-A and B-B and also in the isometric drawing of the corner column, which shows the sequence of the construction. The slab is cantilevered beyond the abutment, and built integrally with the slab is the suspended beam or apron which is to prevent the back fill and drainage from percolating through the construction joints. The cantilever has a theoretical significance in giving greater balance in resistance to the negative moment over the columns. The abutment is in fact a retaining wall, since it takes no slab reaction, and it was possible to reduce its section for the reason that the suspended apron of the slab reduces to a considerable extent the live- and dead-load surcharge pressure against the back of the wall. The reduction in concrete is a saving over ordinary concrete bridge abutments and an appreciable saving over the massive abutments required in support of structural steel bridges, where the top width is fixed by wide bearing plates, or shoes, and a back wall. The wide bridge seat retains water, snow and ice, which are sources of much trouble resulting from their marked deteriorating action on the steel and concrete. Here again it is to be noted that the waterproofing details are reduced to the very simplest arrangement.

Relative to the comparison of the cost of structural steel with the flat slab for the small type railway bridge, it has been found in a number of estimates that a very appreciable difference existed in favor of the flat slab. The statement that the cost of structural steel in one case exceeded the cost of the flat slab by 200 per cent. may seem somewhat surprising. This result was obtained where deck construction would have been required on account of a yard layout involving crossovers on the bridge, and a shallow floor depth made necessary because of close vertical clearances. The estimate included the price of structural steel at its high-water mark. The appreciable saving augmented by the present high price of structural steel, which is likely to continue for some time, should give added impulse to the consideration of flat-slab construction.

From the standpoint of appearance and quantities involved a specific comparison of the flat-slab bridge can be made with a flat-top bridge, the deck of which is the common slab of rectangular cross-section reinforced in the one direction for continuous action over a series of piers. Fig. 8 is an example of the latter type spanning Waverly Place in track elevation through Madison, N.J. The spans of this bridge are almost identical with the spans over Central Avenue, since here the street is also 100 ft. in width, but the slab reinforced in one direction is 12 ins. deeper than the four-way reinforced slab of Central Avenue Bridge, exclusive of the drop panel. If this type were used at Central Avenue at the same unit prices, its cost would exceed that of the present structure by 25 per cent. The noticeable advantage of the Central Avenue Bridge is the clearer vision beyond the bridge obtainable from all angles of approach.

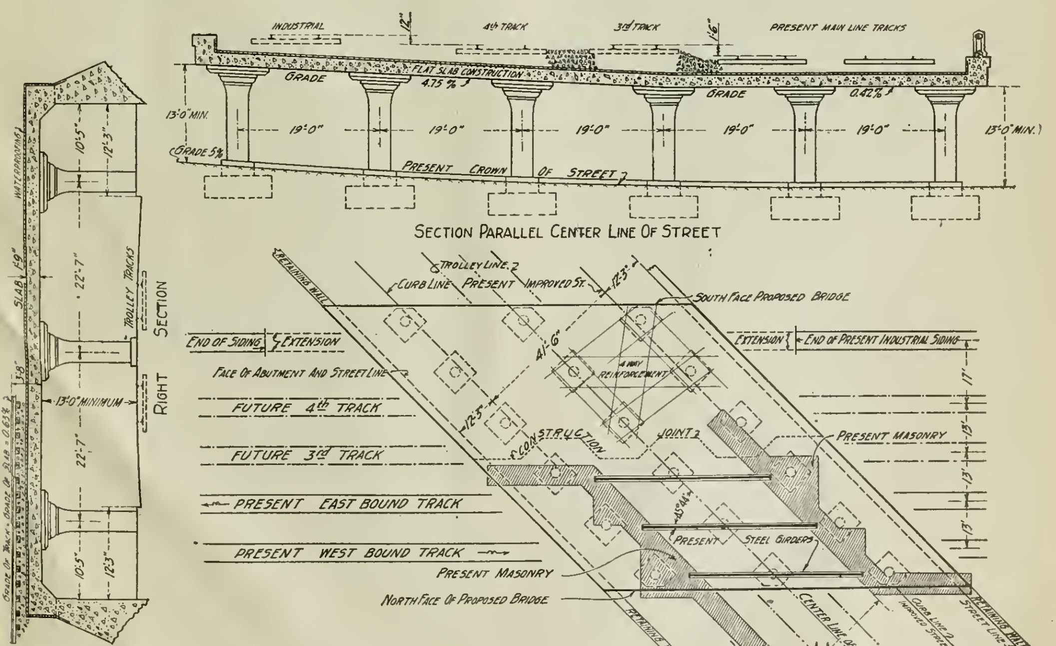

Fig. No. 9—A Proposed Flat-Slab Solution of Difficult Bridge Problem

D., L. & W. R.R. Bridge, No. 9.99

That the flat-slab system has flexible possibilities not obtainable by established bridge construction, a plan, (Fig. 9) of a study in the renewal and extension of the D., L. & W. R.R. Bridge, No. 9.99, is submitted for consideration.

It is here proposed to remove the present two-track steel bridge for the reason that the abutments, 29 ft. apart, encroach upon the 41-ft. 6 in. new driveway, which has been substantially paved with granite block on a concrete base. The bridge is to be extended for future track development on the southerly end, including the installation of an industrial track by extension of the present separate sidings which terminate close to the proposed bridge on either side.

Lateral street intersections fixed the 5 per cent. grade of the street on the southerly side to begin at the face of the present steel bridge, thereby materially encroaching upon the vertical clearance for future expansion of tracks at their present elevation. To overcome this difficulty the flat slab is here tilted in the transverse direction to be approximately parallel with the grade of the present crown of street, and in the longitudinal direction parallel with the grade of the tracks. This flexibleness and the thin slab have resulted in a very shallow floor depth street, and in the longitudinal direction parallel with the grade of effecting the preservation of the established well-ballasted main line tracks, and the extension across the bridge of the industrial siding to the right at its present elevation without resorting to the usual alternative of lowering the street, which in this case would be a very expensive operation. When the future third and fourth tracks are laid, they can easily be established at the elevation 1 ft. 6 ins. above the present tracks necessary to provide the proper amount of ballast.

The most important consideration in the construction of the small type railway bridge on an established alignment is to maintain traffic without interruption during the operation. This is handled in a number of ways. Where the topography will permit, the alignment is shifted temporarily in order that the bridge might be built clear of traffic, in part or in its entirety. Where the right-of-way is of limited width and the tracks cannot be shifted, a timber pile bent trestle of 12-ft. spans is driven under traffic and between these bents, after the excavation has been made the abutment and piers only of the new bridge can be built. Long temporary through girders are often used to span out to out of the new abutment lines in order that the entire bridge may be built underneath. If no old girders are available and the only solution is the timber trestle there arises the exclusion of the flat-slab construction, for the reason that the floor system of the new bridge must be erected beyond the bridge site, either in units or in the whole, followed by a quick removal of the trestle stringers and the installation of the completed floor system on the new masonry during hours of least traffic.

This very important consideration of construction is satisfied in the last example by dividing the work into two parts along the construction joint as indicated. This joint is placed without weakening the strength of the slab and so that the southerly half can be built first without interference with traffic and alongside of present structure by removing only a small portion of the old masonry. The main line tracks will be shifted temporarily to the completed half which gives clear field for the removal of the old bridge and completion of the new structure. The bulkheads of the construction joint are arranged to be practically normal to the bands of reinforcement.

The measure of the advantage in cost of the flat-slab railway bridge, compared with other types, varies considerably and is dependent upon the conditions at hand. There seems to be no question concerning the architectural and structural advantages, the latter results in less maintenance and greater permanence. Of immeasurable value is the simplicity of design and the expediency with which the construction can be carried on. These features are emphasized in the last example which, with its 45° 44′ angle of crossing coupled with the grades of the street and tracks, would considerably complicate the details of design and construction of established bridge practice. The flat-slab design will not require any special consideration on account of these complications. Its flexibility offers much opportunity in overcoming and simplifying other inherent complications of the small type railway bridge.

PROTECTING IRON FROM CORROSION

In a paper read before the Iron and Steel Institute, J. N. Friend summarized as follows the results of his researches on the usefulness of paint for protecting ironwork from atmospheric corrosion: (1) The practical value of acceleration tests is very small in the present state of our knowledge. Reliable results can only be obtained from tests carried out under conditions closely resembling those prevailing in practice. (2) Addition of pigment to oil increases the efficiency of the latter as a protective paint until a maximum is reached. After this, further addition of pigment causes deterioration. The best results are obtainable from paints possessing as high a percentage of good oil as is compatible with good body and any other working property that has to be considered. (3) Linseed oil on setting expands by some 3.3 per cent. This is the primary cause of crinkling. Further oxidation causes a decrease in volume, which in time leads to cracking. (4) Linoxyn is permeable to moisture. The permeability is reduced by heating in absence of air, the oil increasing in density, viscosity, and molecular weight. (5) Polymerized linseed oil affords a better protection than raw oil when used as a paint vehicle. (6) The functions of a pigment are to toughen the film and render it less permeable to water-vapor and oxygen. It also reduces the expansion of the oil on setting, and thus minimizes the tendency to crinkle. (7) A thick coat of paint protects the underlying metal more efficiently than a thin coat, provided the coat is not so thick that running or crinkling takes place. (8) The very best results are obtained by multiple coats. Two thin coats are better than one thick one of equal weight. (9) Thinners enable thin coats of paint to be applied. Turpentine leaves a very slight residue behind upon evaporation, but its effect on the efficiency of the paint is small. (10) Other things being equal, the most permanent paints are those containing black or red pigments, since these absorb the shorter rays of light, and prevent them from hastening the destructive oxidation of the linoxyn by the air. (11) Finer pigments afford more efficient protection than coarse pigments, since they are more thoroughly in contact with the oil. (12) Iron structures should be painted whilst their scale is still on, after loosely adherent flakes and rust have been scraped off. The paint will last rather longer than if applied to the pickled or sand-blasted surface, and the labor of removing the scale is saved. (13) Experiments with rusty plates are not conclusive, but suggest that the rust need not be so carefully removed, prior to painting, as is usually thought to be necessary.

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Principal Contents of this Issue

MOBILIZATION OF LABOR

AGAIN the perennial problem of properly mobilizing the nation's labor power has been brought to the fore. The outbreak of war found Canada faced with a serious situation, in which unemployment and the closing down of industries brought the country to the verge of an economic crisis. The same situation arose in the United States, giving the utmost concern to the authorities everywhere. For a time attention was centered upon the problem of finding work for the unemployed; but the sudden expansion of war work reversed the whole situation and submerged the problem, for the time being, of how best to co-ordinate the labor and industry of the nation.

It is a problem, however, that will not down. It has been extremely difficult since the outbreak of war to find the labor essential for carrying on fundamental war work, both in manufacturing and in agriculture. In the latter, the most difficult phase of the situation is the securing of labor for seeding and harvest. Agriculture, no doubt, is the outstanding example of a seasonal occupation; but there are also many seasonal trades which cause a surplus of labor to emerge at more or less regular intervals. This labor, in the past, has been largely wasted; and there has been also an extravagant waste of labor energy through under-employment, over-employment and the failure, in general, to adequately co-ordinate the labor and industry of the nation.

While the several provinces of the Dominion, and the individual States of the Republic, have had labor bureaux of one sort or another for the providing of men with jobs, and jobs with men, nevertheless, these vital functions have been but poorly performed. Ontario has made a splendid beginning; but the other Canadian provinces lag far in the rear, in the solution of this problem. The truth seems to be that the efficient directing of the country's labor force can be accomplished only under federal authority. The United States has afforded sufficient example of the inefficiency of purely local administration of surplus labor.

A system of federal labor bureaux would effect many economies and cut down the expenses of administration, because directed by a single executive head. It is reasonable to expect that a superior personnel would be secured under the federal supervision of labor bureaux, since those employed therein could be brought under the scope of the Civil Service Act. Moreover, it is necessary to take the national view of the labor problem; to rise above local prejudices; to win the support of organized labor; and, above all, to swing the prestige of the federal government and parliament behind the whole scheme. But, whatever the best solution may be, it is of imperative importance that the problem be attacked now, to the end that our economic life shall not be dislocated at the close of the war.

RECONSTRUCTION IN UINTED KINGDOM

RECENTLY the British Labor Party gave to the world its programme of political and economic reconstruction after the war—a programme which, if carried into effect, is destined, according to the belief of Mr. Arthur Henderson and his confrères, to lay the foundations of a new social order. No doubt the labor parties and the Socialists of Europe expect peace to usher in full democratic control; but they are likely to be disappointed insofar as changes of a fundamental nature in diplomacy, politics and industry are to be accomplished overnight.

Specifically, the British Labor Party demands the enforcement of a minimum wage for all workers; the democratization of industry by giving labor a voice in its management; the shifting of taxes to large incomes and fortunes made during the war; and the appropriation of the surplus wealth of the nation for the common good. These are glittering phases. To what extent can they be translated from the realm of theory and speculation into the hard facts of everyday life?

At the conclusion of the war the United Kingdom will face a stupendous task in dealing with the demobilization of 8,000,000 workers, 5,000,000 of whom are at present engaged in military and naval service. To throw this vast labor force upon the country at a time when war orders have ceased, would effect economic paralysis. The British Labor Party has at least made one constructive proposal—that plans be immediately perfected for the carrying on of great national works, so that unemployment will not be permitted to develop, at least to any appreciable degree. The government of the United Kingdom has itself declared its intention of spending £300,000,000 sterling upon the building of cottages for the working class. Great power stations for the development and distribution of electrical energy may also be undertaken, as well as the extension of the nation's system of light railways and canals. It is obvious that, if national enterprises on a huge scale are started, the demand for materials from private industry will gradually result in the re-establishment of the normal trade and industry of peace.

We are not at all convinced that the war has demonstrated the superiority of State administration over private enterprise, or the capacity of uninformed masses of men to direct and control industry. As for a minimum wage, it is clear that labor cannot get more than it produces—and not even all that it produces; for otherwise

capital would not be attracted to fields that prove unprofitable. Inordinate labor demands will kill industry, both domestic and foreign; for it is plain that a high level of wages, and excessive costs of production, diminish a nation's power to compete in the neutral markets of the world. The future of labor is to be found, not in short hours, inefficient work, and artificial wages, but in technical and trained efficiency and increased production. A just return to capital, commensurate with the risks of industry, and the loyal co-operation of trained and efficient labor will do more to safeguard the standard of living and advance true democracy than the vaporings of any Bolsheviki class, whether at home or abroad.

PERSONALS

R. S. Kelsch, consulting engineer of Montreal, has been elected vice-president of the American Institute of Electrical Engineers.

W. M. Punter, formerly Canadian manager of Saxby & Farmer, Limited, has been appointed signal engineer of the Canadian Northern eastern lines, with headquarters at Toronto.

Dr. Alfred Stansfield, of Montreal, has accepted a commission from Hon. Wm. Sloan, minister of mines for British Columbia, to make a full investigation into the commercial possibilities of the application of electrical smelting methods to the development of the iron ore resources of that province.

Walter Sidney Harvey has resigned from the Department of Works, city of Toronto, to accept a responsible position with the Leaside Munitions Co. Mr. Harvey has been in the sewer drafting section for several years, and for the past few years was in charge of that section. He was more or less responsible for the design of nearly all of the more important sewers constructed in Toronto within recent years. Mr. Harvey was formerly assistant engineer of Lethbridge, Alta.

George A. Johnson, of New York City, has closed his consulting engineering office temporarily, having been commissioned a major in the quartermaster corps of the United States Army. He will be attached to the Construction Division of the Maintenance and Repair Branch, with headquarters at Washington, D.C. Mr. Johnson has been very prominent for many years past in waterworks circles, having done much original filtration and chlorination research work. He has acted as consulting engineer to a number of Canadian municipalities.

OBITUARY

Lieut. John Turner Howard, of the Royal Engineers, a graduate in civil engineering at the University of Toronto, has died from wounds.

In a debate on railways in the Spanish Senate recently Senor Cambo said the government was occupied with a large scheme for the development of hydro-electric energy, and hinted at the existence of a plan for working thus the main railways of the country. As the industrial development of Spain is suffering for lack of communications and transport, and as transport at present depends on coal, the importance of this project is obvious, says the "Railway News." It is interesting to note also that practically all waterfall power plant in the country is run with German machinery, and Germans have been actively surveying and buying properties where this power could be developed on a large scale. There is said to be enough water power in Spain to do the whole work of the country.

ARE SEWERS REMUNERATIVE?

(Continued from page 570)

the housing and rentals. No attempt is made to analyze the over-crowding statistics, though a police census of population is required annually for the purpose of returns to the Departments of Agriculture and to the Ontario and Municipal Railway Board.

The engineering departments are almost as lamentably backward. No effort is made to tabulate the number of premises lacking connection to either the waterworks or the sewers, although in most instances accurate references are kept as to whether an individual premise is connected. And apparently no effort is being made by the boards of health to determine, in sewered municipalities, the number of connected premises; nor is there, with the exception of one or two instances, any well-directed and continuous effort towards compelling all premises to connect to water mains and sewers.

UNION OF CANADIAN MUNICIPALITIES

The eighteenth annual convention of the Union of Canadian Municipalities will be held July 9th-11th, at Victoria, B.C. The session of Wednesday, July 10th, will be under the auspices of the Commission of Conservation and will be devoted to civic improvement work. At this session Thos. Adams, town-planning adviser of the Commission of Conservation, will present a paper on "National and Municipal Housing." During the convention delegates will visit the shipyards located in the vicinity.

CORRECTION

In our issue of April 11th, 1918, appeared an article by W. W. Young on "Emergency Development at Niagara Falls." The heading given to the article would indicate that Mr. Young planned to put temporary penstocks on the crest of Luna Falls. We are advised by Mr. Young that while his article may have been somewhat ambiguous regarding this point, he did not intend actually to build penstocks on the crest of the falls. Mr. Young writes:—

"To simplify for the reader as a method in the very elementary illustration for Luna Falls, I plead guilty of putting penstocks on the crests for the moment, and, with the length of article I felt justified in dictating, did not go into head works details and used 'removable dam' in an after-the-war sense.

"The successive steps of emergency development would result in a continuous spillway weir, with provision for emergencies, well behind the crest of all the falls, to raise the elevation of the water and divert it at right angles into marginal or littoral canals or penstocks along the three shores of Prospect, Goat Island and Victoria Parks. On re-reading I see that I left the matter open to the construction placed on it in the caption, though the one on the map and note is also implied and intended."

United States government supervision of employment for technical men has been inaugurated by the United States Employment Service, through the establishment of a division of engineering, with A. H. Krom, of Chicago, as director. Mr. Krom is a graduate of Purdue University and was formerly secretary of the American Association of Engineers. Recently he was engineer-in-charge of the Chicago office of the State Public Utilities Commission of Illinois.